2001

Inventing Your Own Academic Degree & Research Institute (presentation to University of California)

Zyda, Michael

Inventing Your Own Academic Degree & Research Institute

Michael Zyda, Director
zyda@movesinstitute.org

Outline

Bio

What is the Naval Postgraduate School

A Brief History of the MOVES Program

MOVES Academic Program

The MOVES Institute Research Program

Zyda Bio

DSc in Computer Science, Washington University, St. Louis, 1984.

MS in Computer Science/ Neurocybernetics, Univ. of Massachusetts, Amherst, 1978.

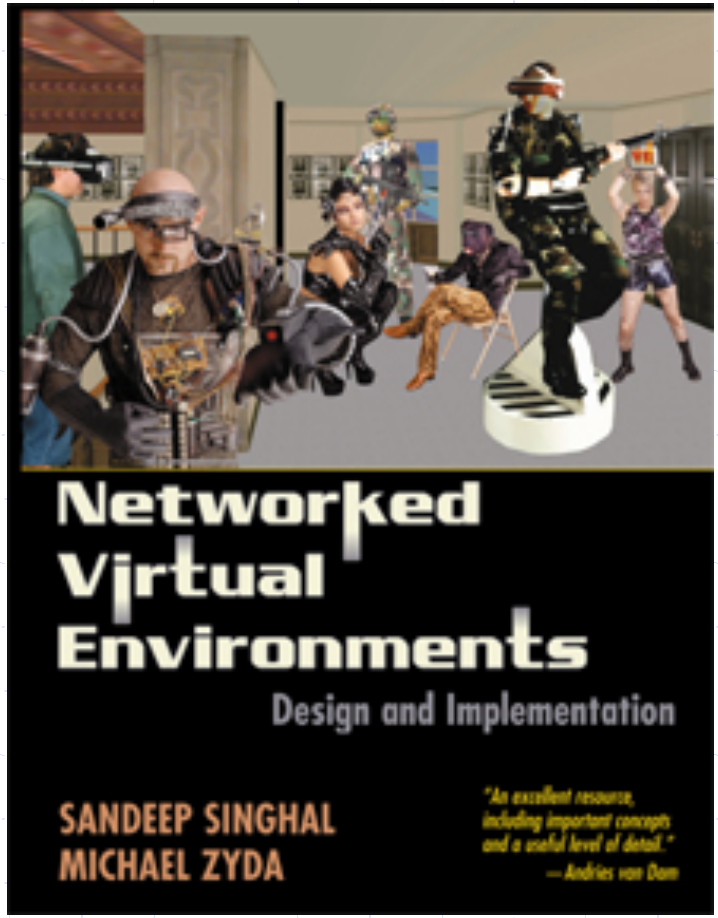
BA in Bioengineering, Minor in Spanish Literature, UCSD, 1976.

Zyda Bio

Founder & Director of the MOVES Institute

Research interests:

- Computer graphics, large-scale, networked 3D virtual environments, computer-generated characters, video production, entertainment/ defense collaboration, and modeling and simulation



Zyda Bio - NRC 1992 - 1995

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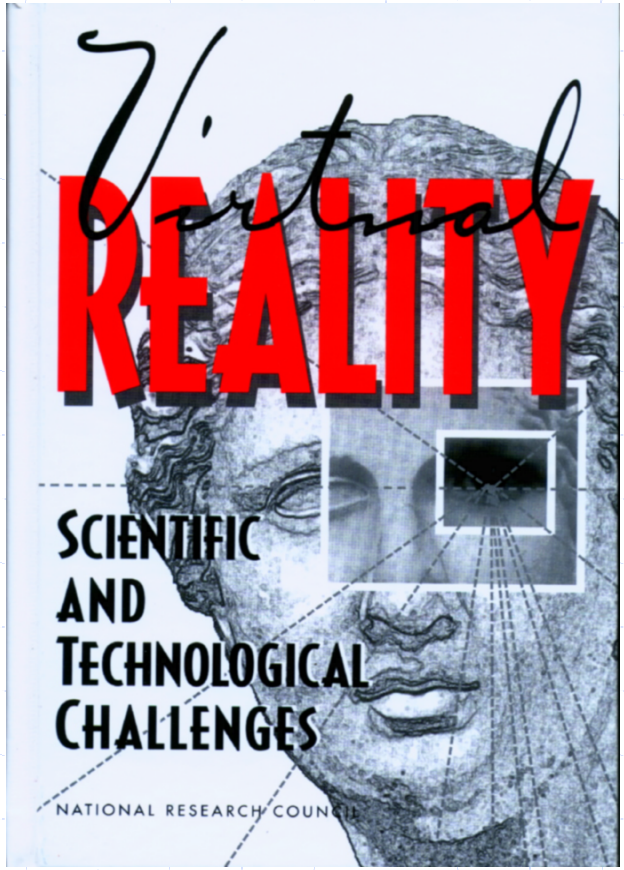
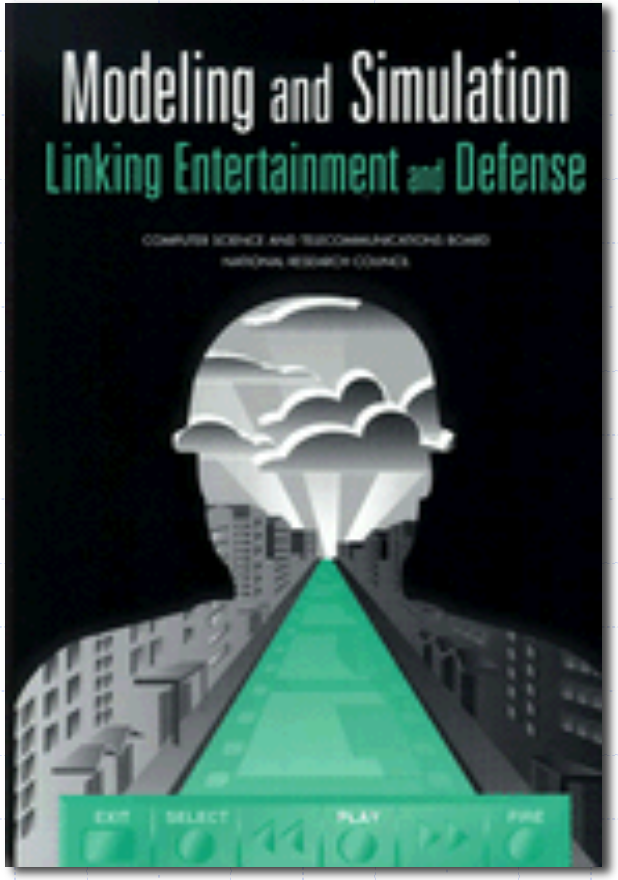
Zyda is one of the lead authors of the NRC Commission on Behavioral & Social Sciences report "Virtual Reality - Scientific & Technological Challenges"



Zyda Bio - NRC 1996 - 1997



Professor Zyda chaired the NRC Computer Science & Telecommunications Board report "Modeling & Simulation - Linking Entertainment & Defense"

Michael Zyda - NRC 1998 - 2000

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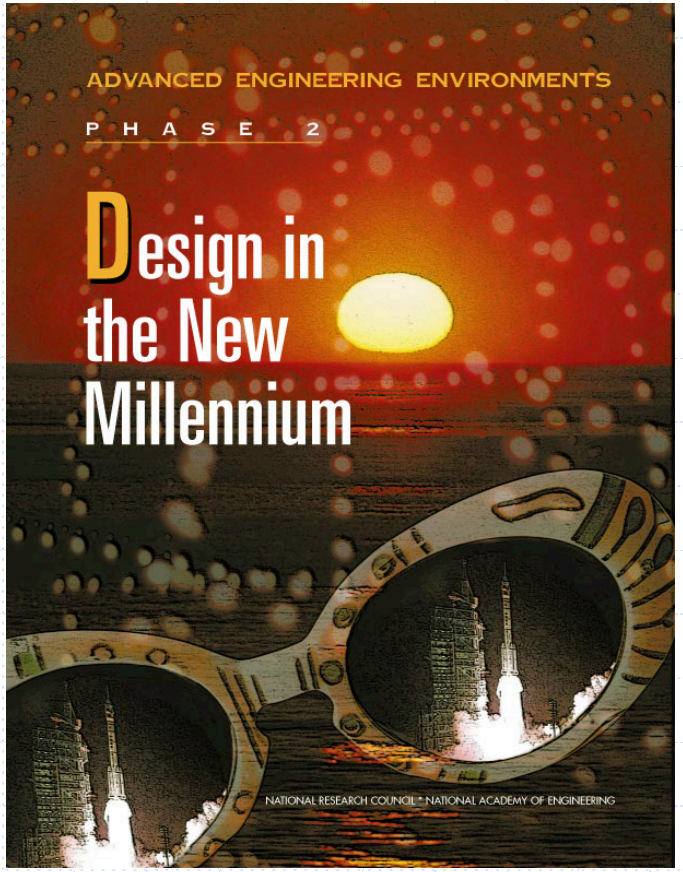
Professor Zyda was a member of the NRC Aeronautics & Space Engineering Board Committee on Advanced Engineering Environments, which has produced two reports on how NASA should design space systems in the future (2015), using VEs of course!



Zyda Consulting

White House Office of Science and Technology Policy, the Ministry of Industrial Development Sabah Province, Malaysia, Japan Tech Services Corporation, Tokyo, Hitachi Plant Construction & Engineering, Ohtsuka, SimGraphics Engineering,

Silicon Graphics International, Geneva, Nihon Silicon Graphics KK, Advanced Telecommunications Inc., TecMagik, SpiritChannel.com, Walt Disney Corp., Paramount Digital Entertainment, Celebrity Speakers, International.

The Naval Postgraduate School

What is NPS?

The MOVES Institute
Naval Postgraduate School

A graduate school that provides professional (MS & PhD level) education for the US & foreign military:

- Students are Naval officers, Army officers, USMC, civilian employees of the federal govt & about 35% are officers of foreign militaries

NPS Organization

School of International Graduate Studies

School of Business & Public Policy

School of Engineering & Applied Sciences

School of Operational & Information Sciences

Institute for Systems Engineering & Analysis

Institute for Information Superiority & Innovation

The MOVES Institute

NPS Size

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Naval Postgraduate School

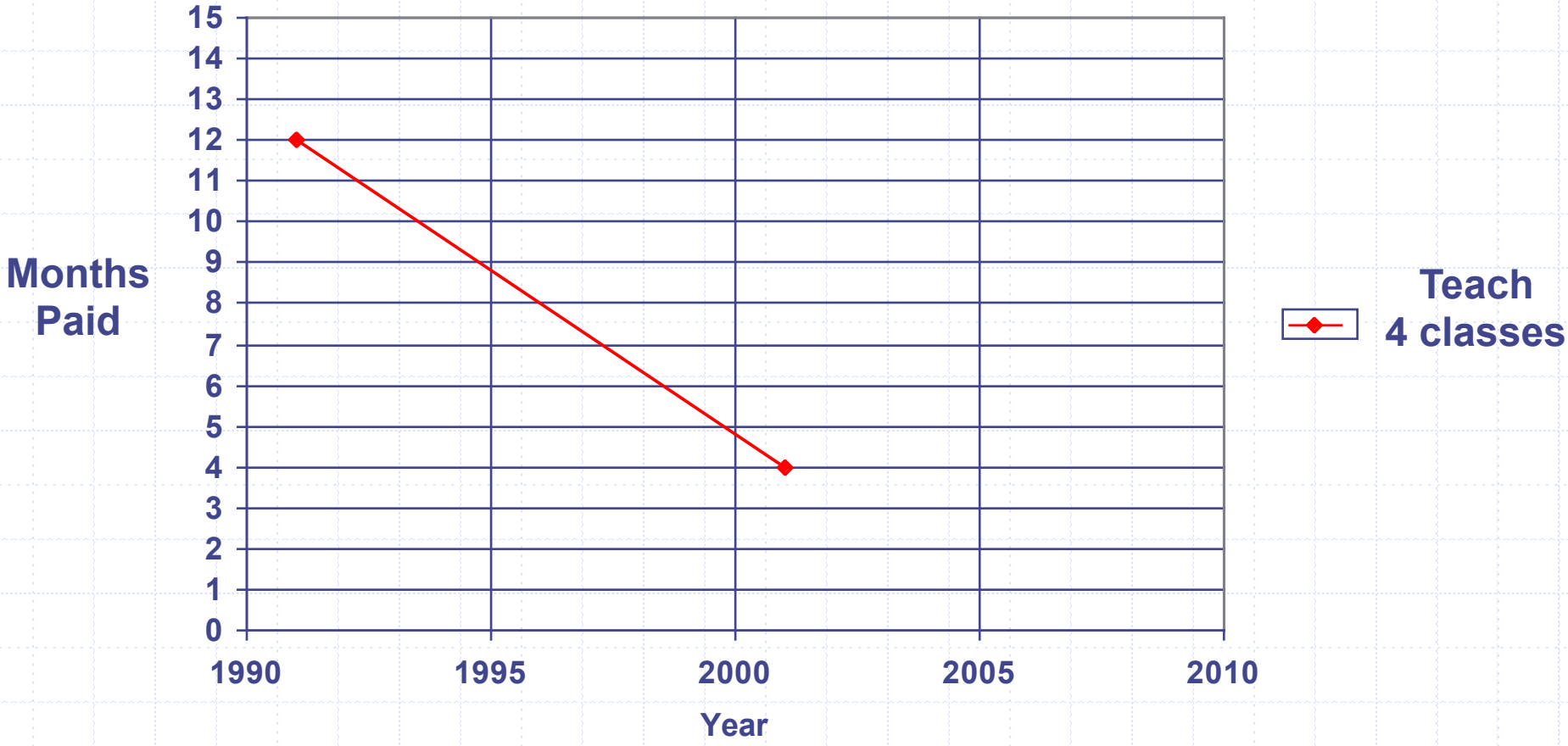
Civilian Side

- 1 Provost
- 25 Vice Provosts & Deans & Associate/ Assistant Deans
- 200 Faculty

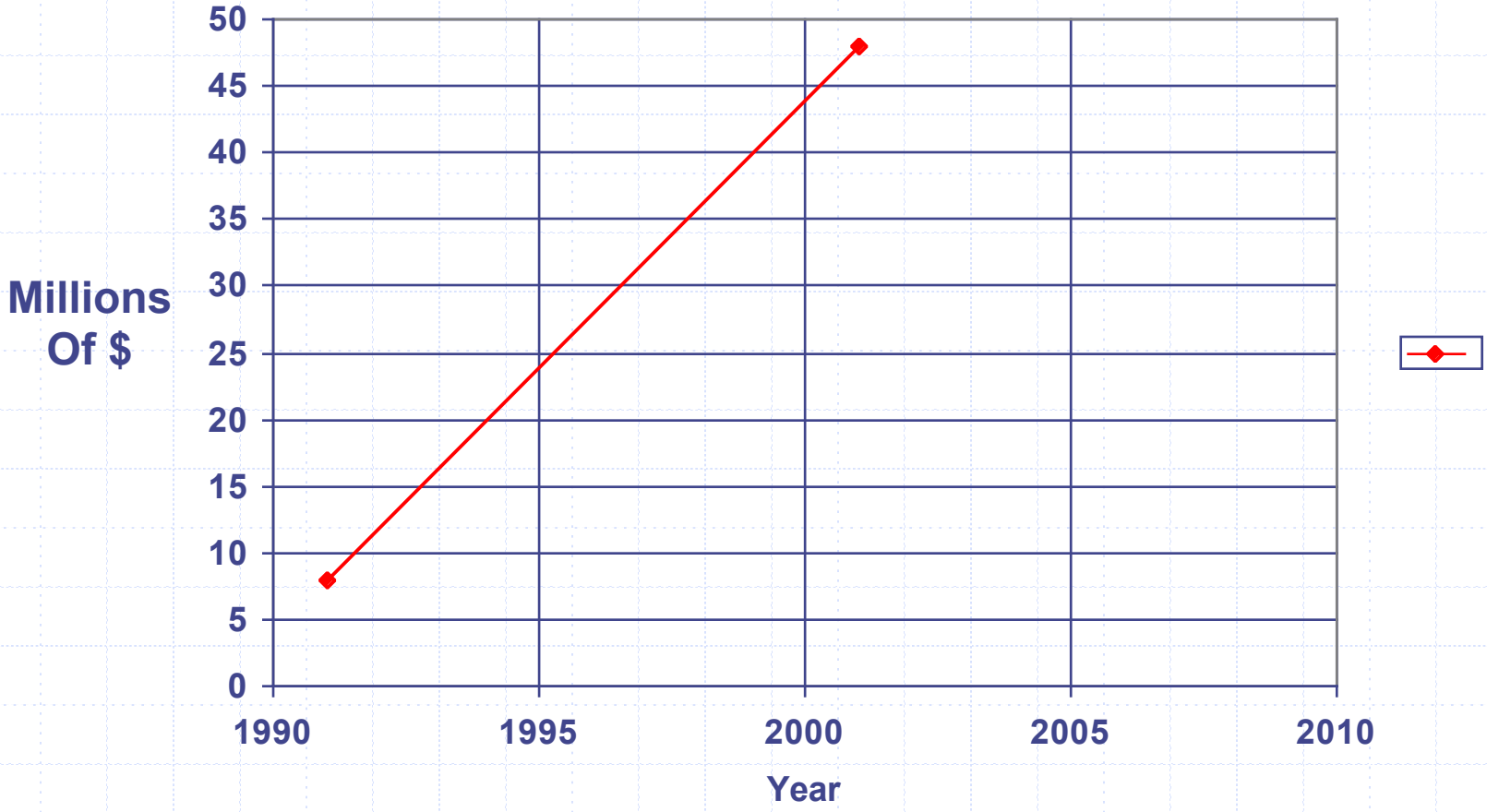
Military Side

- 1 Superintendent
- 6 Navy Captains
- 26 CDRs/LCDRs
- Lots of LTs…
- 1,100 students

NPS Mission Budget



NPS Reimbursable Funding



Size of MOVES Institute

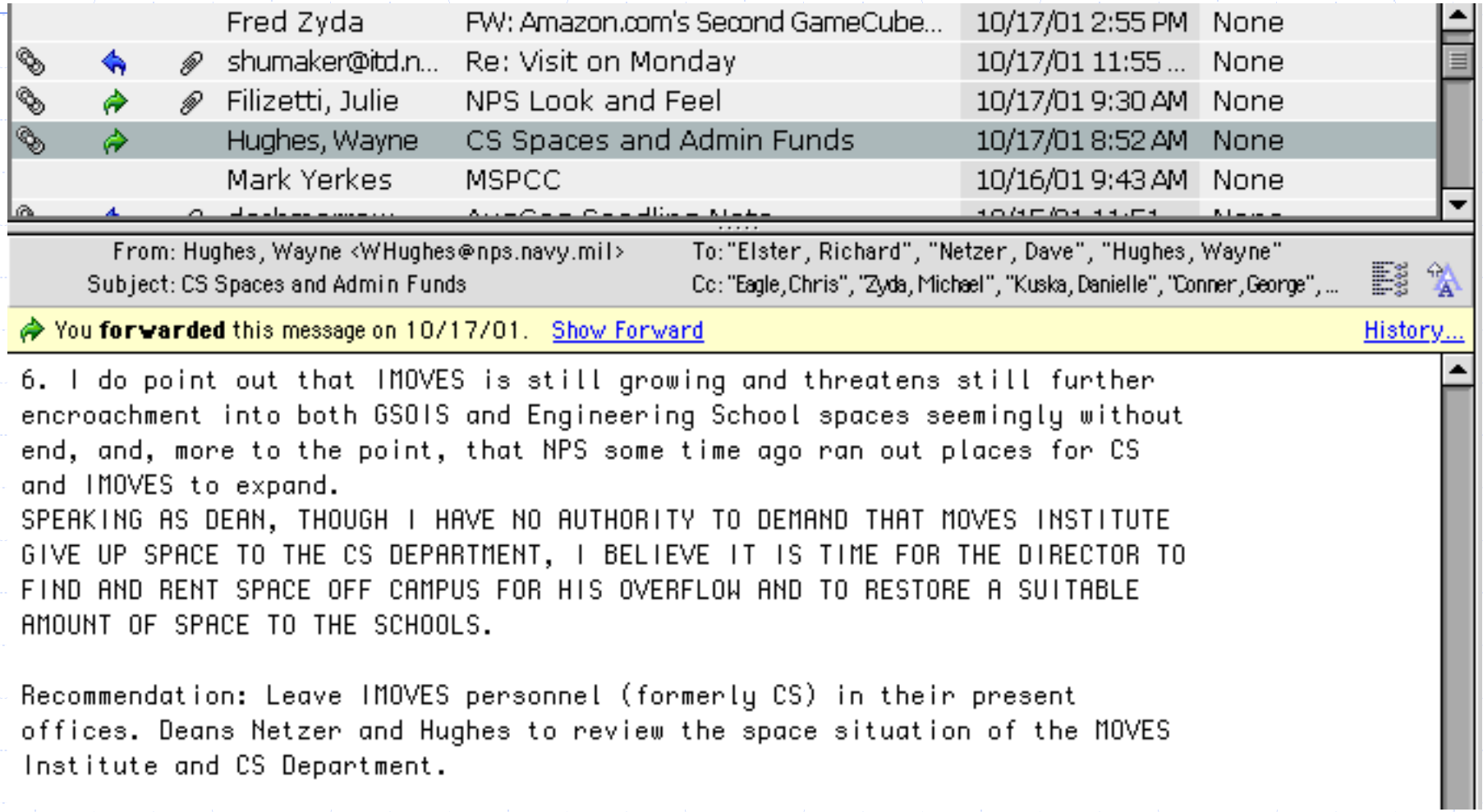
We pay 46 faculty & staff.

We have 40 military officer students working on MS degrees.

We have 6 PhD students.

We have $12M in reimbursable funding, which is 25% of all NPS reimbursable funding.

Email from the Dean



Fred Zyda	FW: Amazon.com's Second GameCube...	10/17/01 2:55 PM	None
shumaker@itd.n...	Re: Visit on Monday	10/17/01 11:55 ...	None
Filizetti, Julie	NPS Look and Feel	10/17/01 9:30 AM	None
Hughes, Wayne	CS Spaces and Admin Funds	10/17/01 8:52 AM	None
Mark Yerkes	MSPCC	10/16/01 9:43 AM	None

From: Hughes, Wayne <WHughes@nps.navy.mil>
To: "Elster, Richard", "Netzer, Dave", "Hughes, Wayne"
Subject: CS Spaces and Admin Funds
Cc: "Eagle, Chris", "Zyda, Michael", "Kuska, Danielle", "Conner, George", ...

You **forwarded** this message on 10/17/01. Show Forward History...

6. I do point out that IMOVES is still growing and threatens still further encroachment into both GSOIS and Engineering School spaces seemingly without end, and, more to the point, that NPS some time ago ran out places for CS and IMOVES to expand.
SPEAKING AS DEAN, THOUGH I HAVE NO AUTHORITY TO DEMAND THAT MOVES INSTITUTE GIVE UP SPACE TO THE CS DEPARTMENT, I BELIEVE IT IS TIME FOR THE DIRECTOR TO FIND AND RENT SPACE OFF CAMPUS FOR HIS OVERFLOW AND TO RESTORE A SUITABLE AMOUNT OF SPACE TO THE SCHOOLS.

Recommendation: Leave IMOVES personnel (formerly CS) in their present offices. Deans Netzer and Hughes to review the space situation of the MOVES Institute and CS Department.

An Intro to MOVES

Definition

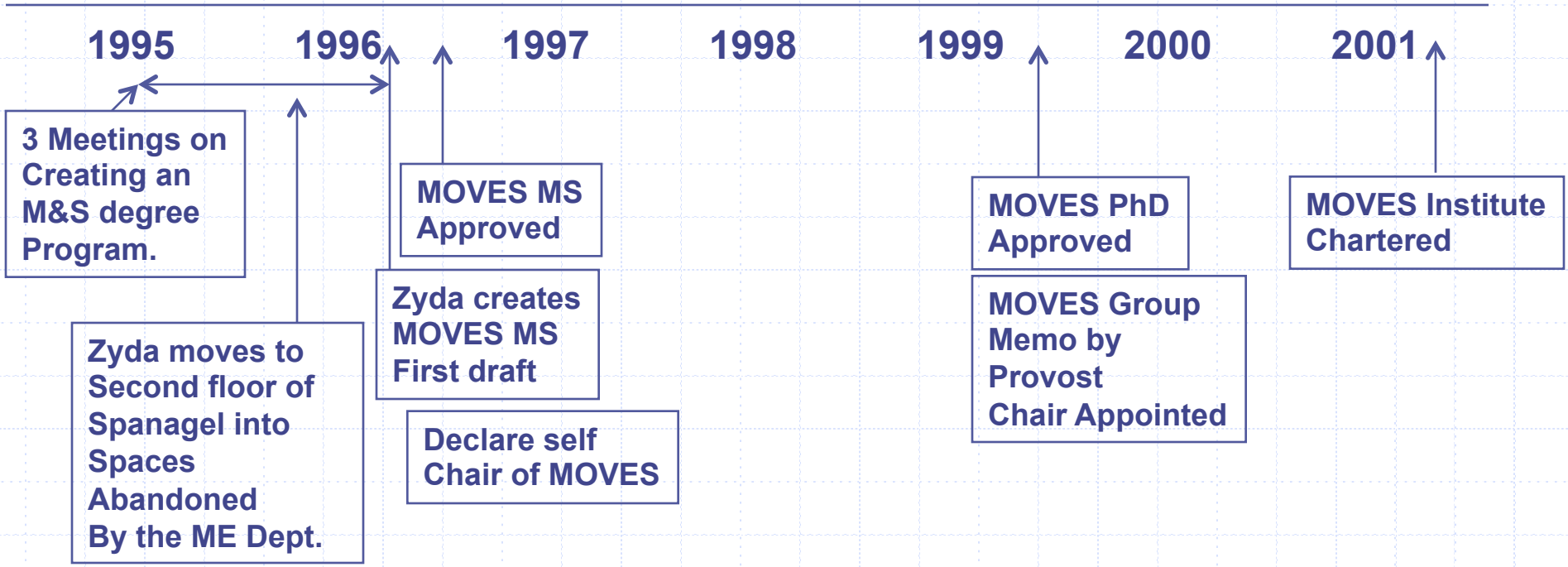
MOVES

- Modeling, Virtual Environments & Simulation

Three Goals from the Start

- Create a new degree program (MS & PhD) and thereby the basis for a new field
- Create an academic department
- Create a research institute

History of MOVES



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Academic Program

The Modeling, Virtual Environments and Simulation (MOVES) MS and PhD Programs

Academic Program

The MOVES MS degree program is about one third Operations Research, one third Computer Science, and one third MOVES specific course material.

Scope of the MOVES MS Program

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Programming

Object-oriented programming, data structures, artificial intelligence

Systems & Architecture

Computer systems principles, operating systems, distributed operating systems

Computer Graphics

Computer graphics, image synthesis, computer animation, computer graphics using VRML

Visual Simulation Track Human Performance Engineering Track

29 classes total in the MOVES MS

Mathematical Fundamentals

Multivariable calculus, linear algebra, probability & statistics

Communications & Networks

Network communication in simulation, virtual environment network & software architectures

Virtual Environments

Virtual world & simulation systems, human factors of virtual environments, training in virtual environments

Modeling & Simulation

Stochastic models, system simulation, simulation methodology, introduction to joint combat modeling, physically-based modeling, agent-based autonomous behavior for simulations

Human Performance Engineering

Interactive computation systems, human performance measurement, human performance evaluation, human factors in system design

MOVES Graduate Capabilities

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We expect our graduates to be capable of supporting and developing modeling, virtual environment and simulation systems another order of magnitude more complex than those of today.

- Our graduates are the architects of the next-generation of combat modeling, simulation & virtual environment systems.

Subspecialty definition

The MOVES MS program is

- the definition for the Navy's subspecialty (6202/xx99 P-code) in modeling and simulation,
- the definition for the Marine Corps' modeling and simulation subspecialty (MOS 9625), and
- the definition for the US Army's Simulation Operations functional area (FA-57).

MOVES PhD Program

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PhD Areas of Study

- Physically-based modeling for virtual environments
- Networked virtual environments
- Human factors in virtual environments
- Adaptable software agents
- Modeling human and organizational behavior
- Discrete-event systems modeling
- Data and model visualization

The MOVES Institute

Research Programs

Mission

Research, application and education in the grand challenges of modeling, virtual environments and simulation.

- The institute operates both independently and in collaboration with the various Navy and Defense centers to:
  - carry out basic and applied research;
  - analyze modeling, virtual environments and simulation programs;
  - create advanced prototypes; and
  - develop technologies and applications for the defense community.

Research Scope

Our scope encompasses the fundamentals and applications required for the next generation including:

- 3D Visual Simulation
- Networked Virtual Environments
- Computer-Generated Autonomy
- Human Performance Engineering
- Technologies for Immersion
- Defense and Entertainment Collaboration
- Evolving Operational Modeling

From fundamentals to application

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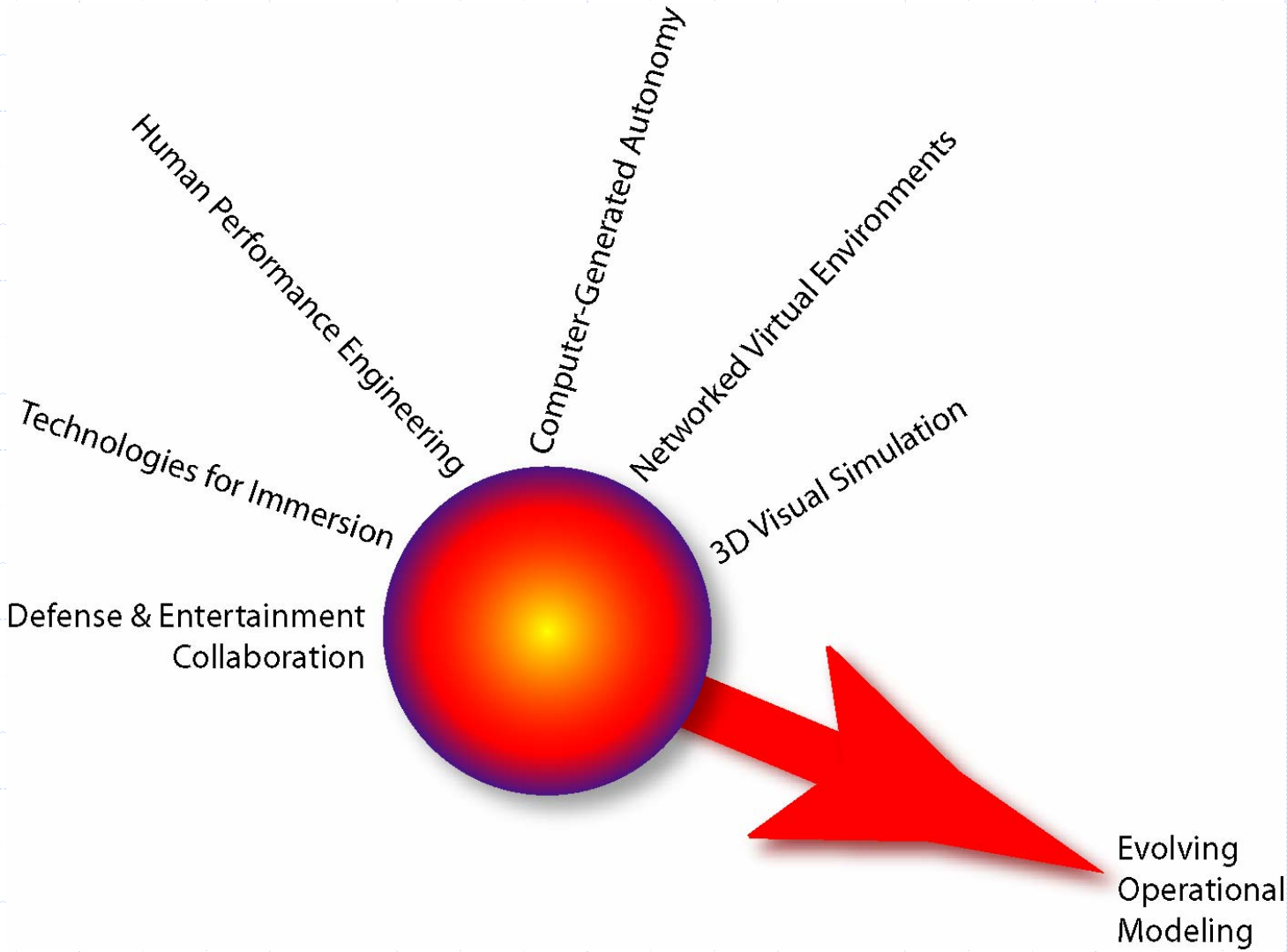

Organizational Structure

The MOVES Institute
Naval Postgraduate School

Director

- Michael Zyda

Technical Directorate

- John Hiles - Computer-Generated Autonomy
- Don Brutzman - 3D Visual Simulation & Networked Virtual Environments
- Rudy Darken - Human Performance Engineering & Technologies for Immersion
- Michael Capps - Defense & Entertainment Collaboration
- Alex Callahan - Evolving Operational Modeling

Organizational Structure

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- Infrastructure Director
  - John Falby
- Research Programs Director
  - Open
- Products Director
  - David Williams
- Technical Writer & Web Support
  - Margaret Davis
- Technical Support
  - Meg Boone

Executive Advisory Board

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Naval Postgraduate School

Executive Advisory Board provides guidance on funding for research and products.

- VADM Richard Mayo, USN - N6
- RADM Lee Kollmorgen, USN (ret)
- CAPT Dennis McBride, USN (ret), PhD - VP, Potomac Institute
- Dr. Harold Hawkins, ONR
- CAPT Mike Lilienthal, USN - Director of DMSO
- Dell Lunceford - Director of AMSO
- Dr. Mike Bailey - Director, USMC Combat Developments Center
- Michael Kapp - Founder & President Time Warner Special Projects (ret)

Technical Advisory Board

Technical Advisory Board provides guidance on technical alternatives to proposed research and products.

- Dr. Phil Barry, DMSO Chief of S&T Division
- CAPT Richard Bump, USN - Director, Navy Modeling & Simulation Management Office, N6M
- Jim Weatherly - Deputy Director, Navy Modeling & Simulation Management Office, N6M
- LCDR Dylan Schmorrow, USN – ONR VIRTE Program Manager & DARPA Program Manager
- Dr. Bowen Loftin - Old Dominion University, Director VMASC
- Brian Goldiez - Director, UCF Institute for Simulation & Training

Collaborations

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Academic

- Boston College
- CalPoly
- Carnegie-Mellon University
- CSUMB
- ENIT, France
- George Mason University
- Georgia Tech, MSREC
- INRIA
- Miami University
- MIT Lincoln Laboratories

Academic

- Old Dominion University, VMASC
- Queens University, Kingston, Ontario
- UCB, Center for Design Visualization
- UCF IST
- UCSC
- University of Newcastle, Newcastle-upon-Tyne
- University of Virginia

Non-Profit

- Fraunhofer Center for Research in Computer Graphics
- CNA
- HPCC, Maui
- Institute for Defense Analysis
- MBARI
- Monterey Bay National Marine Sanctuary
- Sea Grant
- S. E. A. Lab Monterey Bay

Collaborations

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Corporate

- Bios Group
- Boeing
- Dolby
- Emergent Designs
- Epic Games
- John Mason Associates

Corporate

- Lucasfilm Skywalker Sound
- Lucasfilm THX
- Microstrain
- MITRE
- Nexternet
- Potomac Institute
- Rolands & Associates
- SAIC

Collaborations

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Navy

- CHSWP, Helicopter Wing Pacific Fleet
- Commander, Submarine Development Squadron TWELVE
- HS-8 - Helicopter Anti-Submarine Squadron EIGHT, FRS
- HS-10 - Helicopter Anti-Submarine Squadron TEN, FRS
- Navy Modeling & Simulation Management Office, N6M
- Naval Oceanographic Office
- Naval Research Laboratory

Navy

- Naval Research Laboratory, Electronic Warfare Group
- Naval Sea Systems Command, Advanced Systems & Technology Office
- Naval Submarine School
- Navy Toxicology Detachment, Wright Patterson Air Force Base
- Naval Undersea Warfare Center, Newport
- NAWC-TSD
- Office of Naval Research
- Third Fleet

Marines

- Marine Corps Combat Developments Center
- Marine Forces Pacific
- Training & Education Command

Collaborations

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OSD

- DARPA
- Defense Modeling & Simulation Office
- Defense Threat Reduction Agency
- J9
- Office of the Director, Operational Test & Evaluation
- Office of the Secretary of Defense
- OSD Program Analysis & Evaluation

Army

- Army Research Office
- Assistant Sec. Army for Manpower & Reserve Affairs
- Office of Economic & Manpower Assessment
- TRAC Monterey
- TRADOC
- USA OTC, Fort Hood

Air Force

- Medical Command, San Antonio

MOVES Institute Space

The MOVES Institute is distributed across several buildings on the NPS campus.

Spanagel Hall (second floor, approximately 4,300 square feet)

- Software Development Laboratory
- Conference room
- Faculty/staff offices

MOVES Institute Space

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and the Mechanical Engineering (ME) building (second floor, approximately 5,000 square feet).

- The War Game Laboratory
- Video Production Laboratory
- Conference Room
- VR CAVE Theater (in construction FY 2002)
- Software Production Facility
- Faculty/staff offices

MOVES Institute Space

In March 2002, construction will begin on a three-story annex to the ME building, providing approximately 21,000 square feet to

- consolidate faculty/staff offices,
- conference space, and
- classrooms of the MOVES Institute.
- opening is scheduled for March 2003.

Projects

3D Visual Simulation

3D Visual Simulation

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- Project VAST - Virtual At Sea Training
- Third Fleet - Tactical Information Visualization
- Generic Hub: XML-Based Information Interchange for Defense Messaging, Shipboard/ Theater Command & Control, and Distributed 3D Battlespace Visualization

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Networked Virtual Environments

Networked Virtual Environments

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- NPSNET-V - An Architecture for Constructing Scalable, Dynamically Extensible, Networked Virtual Environments
- Explorations in Dynamic Extensibility & Dynamic Behavior Protocols for Web-Based, Networked Virtual Environments
- Virtual Reality Transfer Protocol (vrtp) Development

NPSNET-V

An Architecture for Creating Scalable, Dynamically Extensible Networked Virtual Environments

Andrzej Kapolka
kapolka@cs.nps.navy.mil

Don McGregor
mcgredo@nps.navy.mil

Don Brutzman; Michael Capps; MAJ Bill Fischer, USA;
MAJ Dave Washington, USA; LTCDR Scott Wathen, USN; Michael Zyda

Introduction to NPSNET-V

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The Dream

- A framework for fully distributed, component based, persistent networked virtual worlds. Extensible at runtime and scalable to infinite size on the Internet
- An architecture, not an application
  - Developers create worlds in a straightforward, modular fashion by configuring and combining prefabricated building blocks, creating new blocks when necessary
  - Developers' applications are windows into their worlds

Project Goals

Explore new research directions

- Scalability via novel techniques in area-of-interest management and multiresolution modeling
- Componentization for run-time adaptability and extensibility
- Boundaries between code and content, syntax and semantics

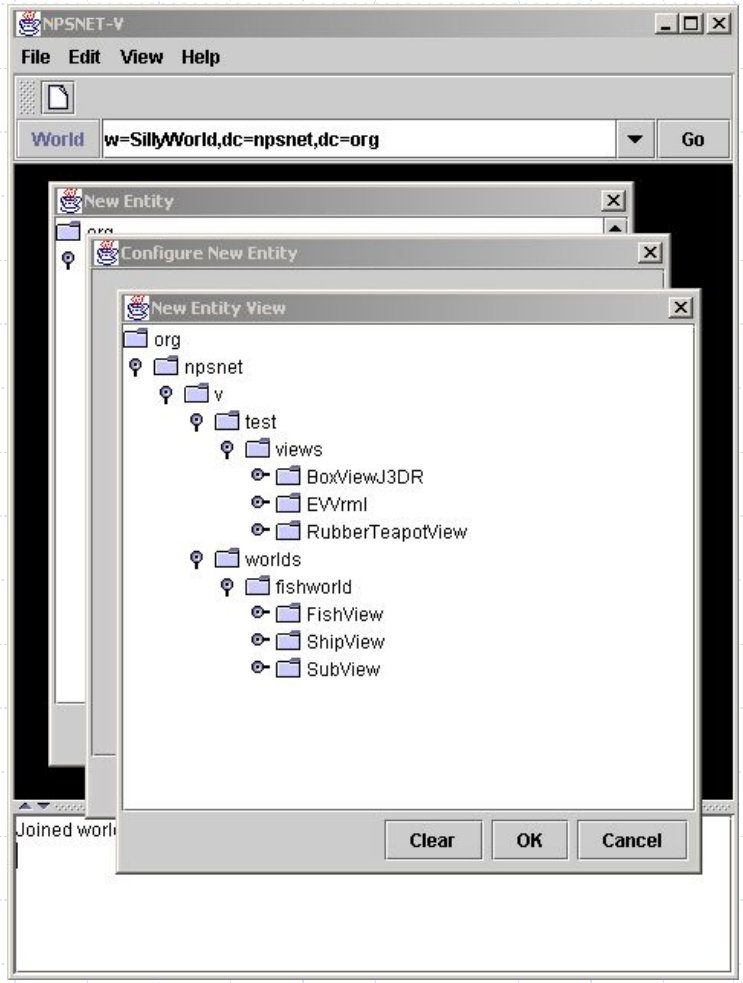
Provide common framework for MOVES research

Encourage multidisciplinary interaction

Current State of Development

World Browser/Builder

- Provides an intuitive interface for world authors and world participants
- Offers a robust, extensible GUI framework



Current State of Development

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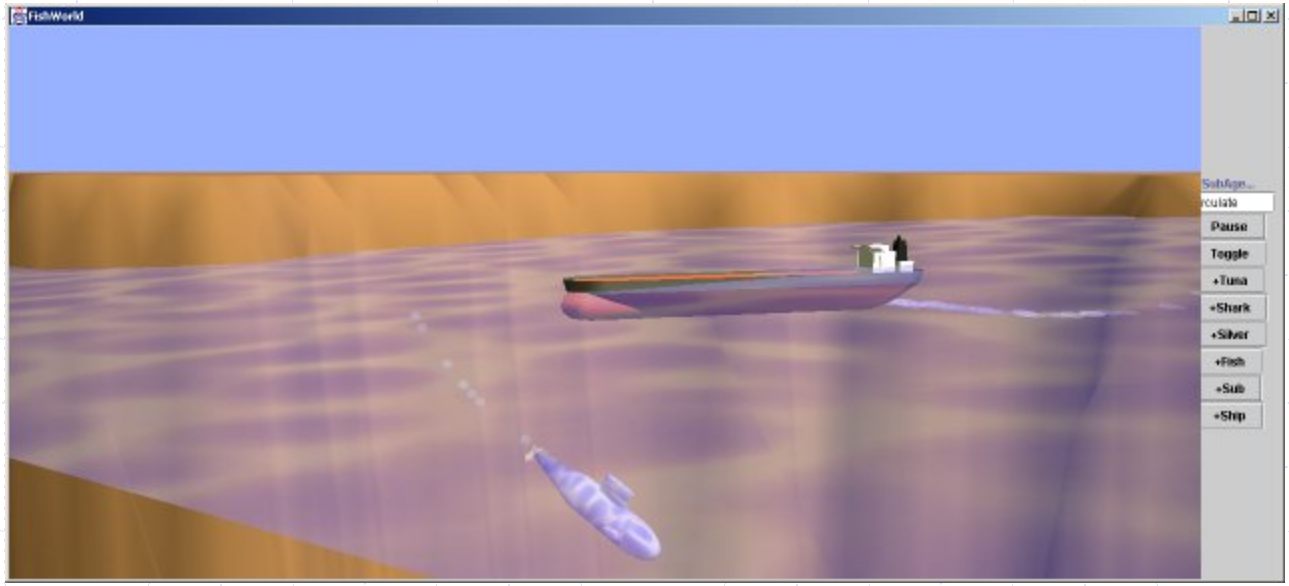
FishWorld

- An interactive aquarium simulation
- Demonstrates integration of agent-controlled entities



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Computer-Generated Autonomy

Computer-Generated Autonomy

- A Symbolic Reactive Agent Architecture for Multi-Agent Systems
- Interactive Computer Generated Stories
- DMSO - Self-Learning Autonomous Agents for Distributed Simulations

Symbolic and Reactive Agents

Professor John Hiles jhiles@mindspring.com
Major Michael VanPutte, USA mavanput@nps.navy.mil
Commander Brian Osborn, USN baosborn@nps.navy.mil

Agent

A software entity that is situated in some environment, and is capable of autonomous action in this environment in order to meet its design objective

Properties

- Situated
- Autonomous
- Proactive
- Reactive
- Social

Motivation

Build a composite agent architecture

- Combine the strengths of cognitive agents and reactive agents
- Highly adaptive, innovative behavior
- Constrained procedural behavior
- Easier and more rapid development of complex and adaptive simulations

Composite Agent

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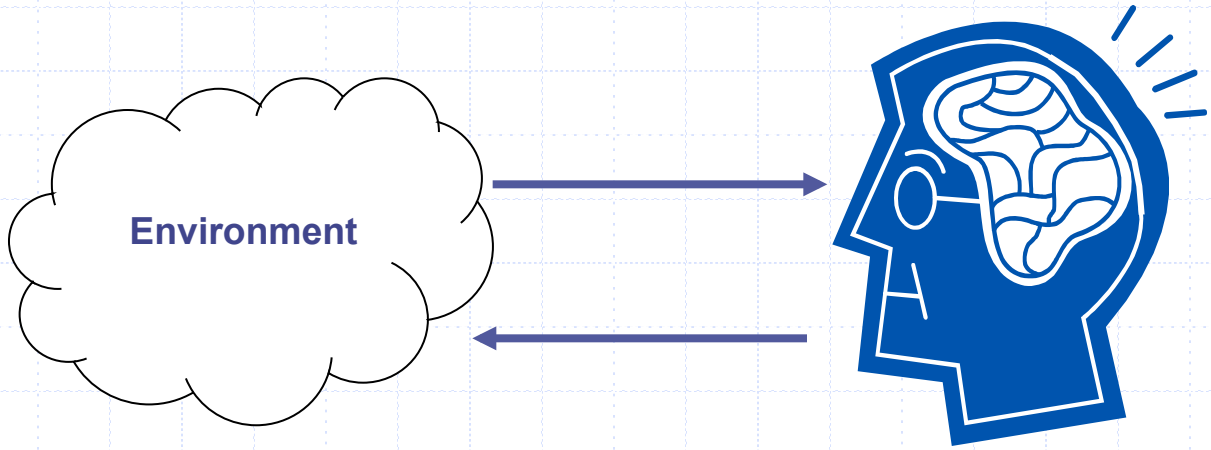
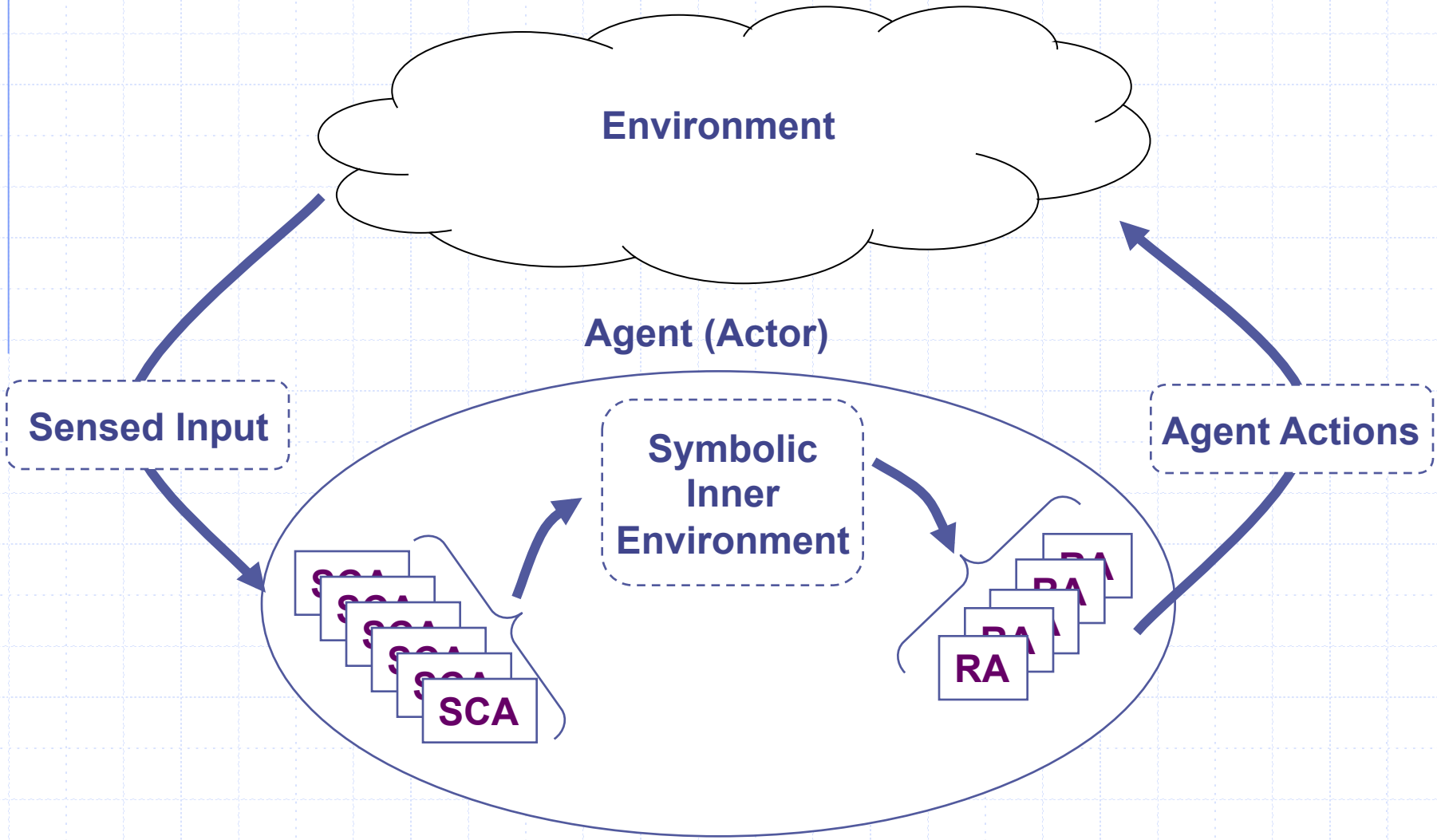
Hybrid Agent Architecture

- Set of agents that sense the world and create a *symbolic inner environment*
- Set of reactive agents that take the symbolic inner environment and chose actions to perform
- Unique data structure called tickets that allows us to incorporate procedural knowledge in reactive agents



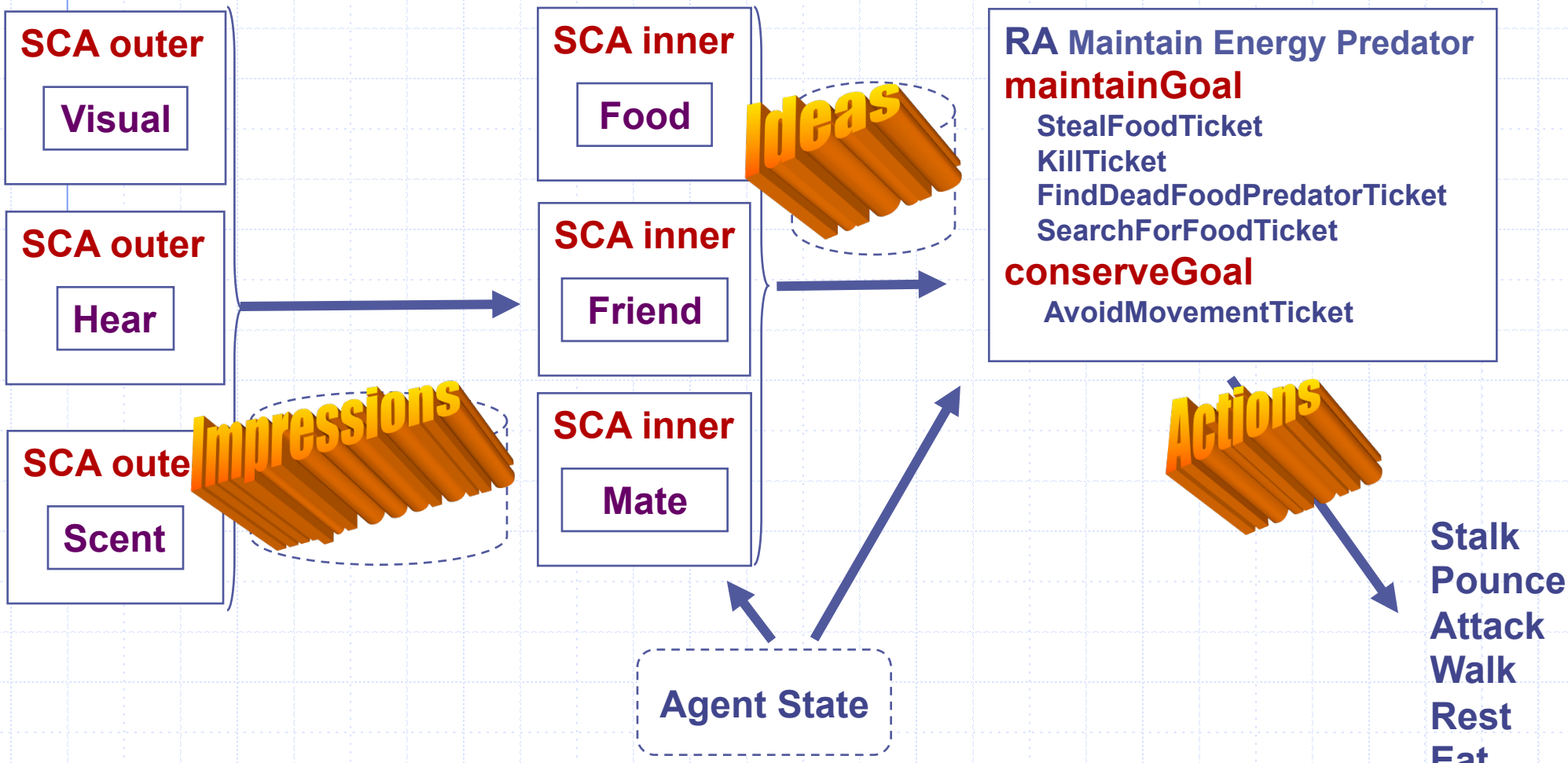
Composite Agent



Symbolic Constructor Agents (SCA)

- Defines the agent's sensor capabilities
- Controls impressions of the outer environment
- Receives input from outer environment and convert these into the symbolic inner environment (impressions)

Example - GPW


SCA outer
Visual
SCA outer
Hear
SCA outer
Scent
Impressions
SCA inner
Food
SCA inner
Friend
SCA inner
Mate
Ideas
RA Maintain Energy Predator
maintainGoal
StealFoodTicket
KillTicket
FindDeadFoodPredatorTicket
SearchForFoodTicket
conserveGoal
AvoidMovementTicket
Actions
Agent State
Stalk
Pounce
Attack
Walk
Rest
Eat

Computer Generated Interactive Stories

Prof. John Hiles
Jhiles@mindspring.com

CDR Brian Osborn
baosborn@nps.navy.mil

Modeling & Simulation - Linking Entertainment & Defense

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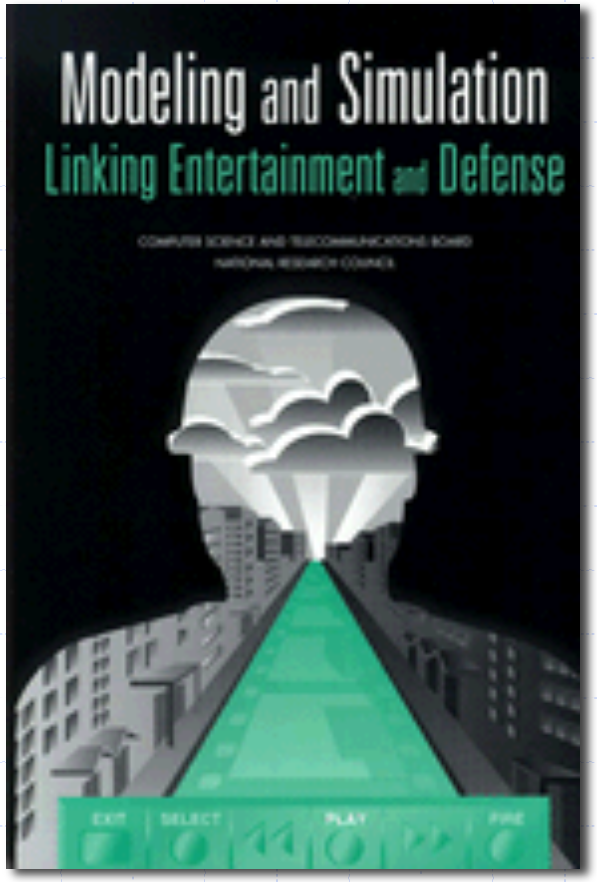
"… skilled storytelling techniques help participants in a virtual environment sense that they are in a real environment and behave accordingly."

Develop autonomous agent technology to carry out high level behavior of characters in a networked virtual environment

Develop technology to guide those behaviors within the parameters of a given story line.



Motivation

National Research Council Report

Applications

- Scenario Based Training
- War Gaming
- Interactive Entertainment

Interactive Story

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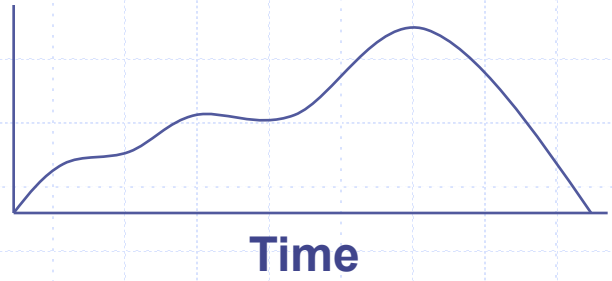
Virtual World

Believable Autonomous Characters

Interactive User – Direct or indirect participant in the story…not an observer!

Dynamic Storyline

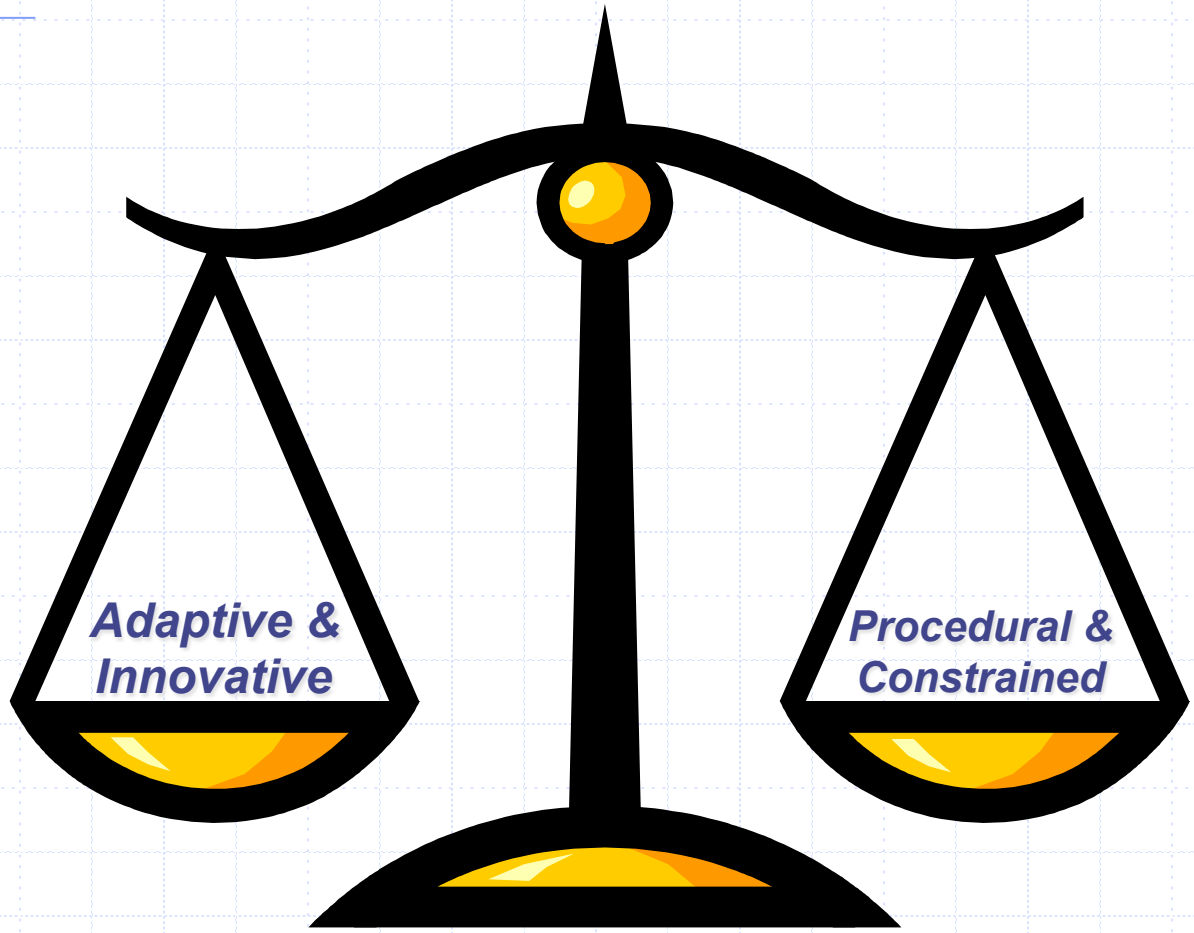
Dramatic Presentation



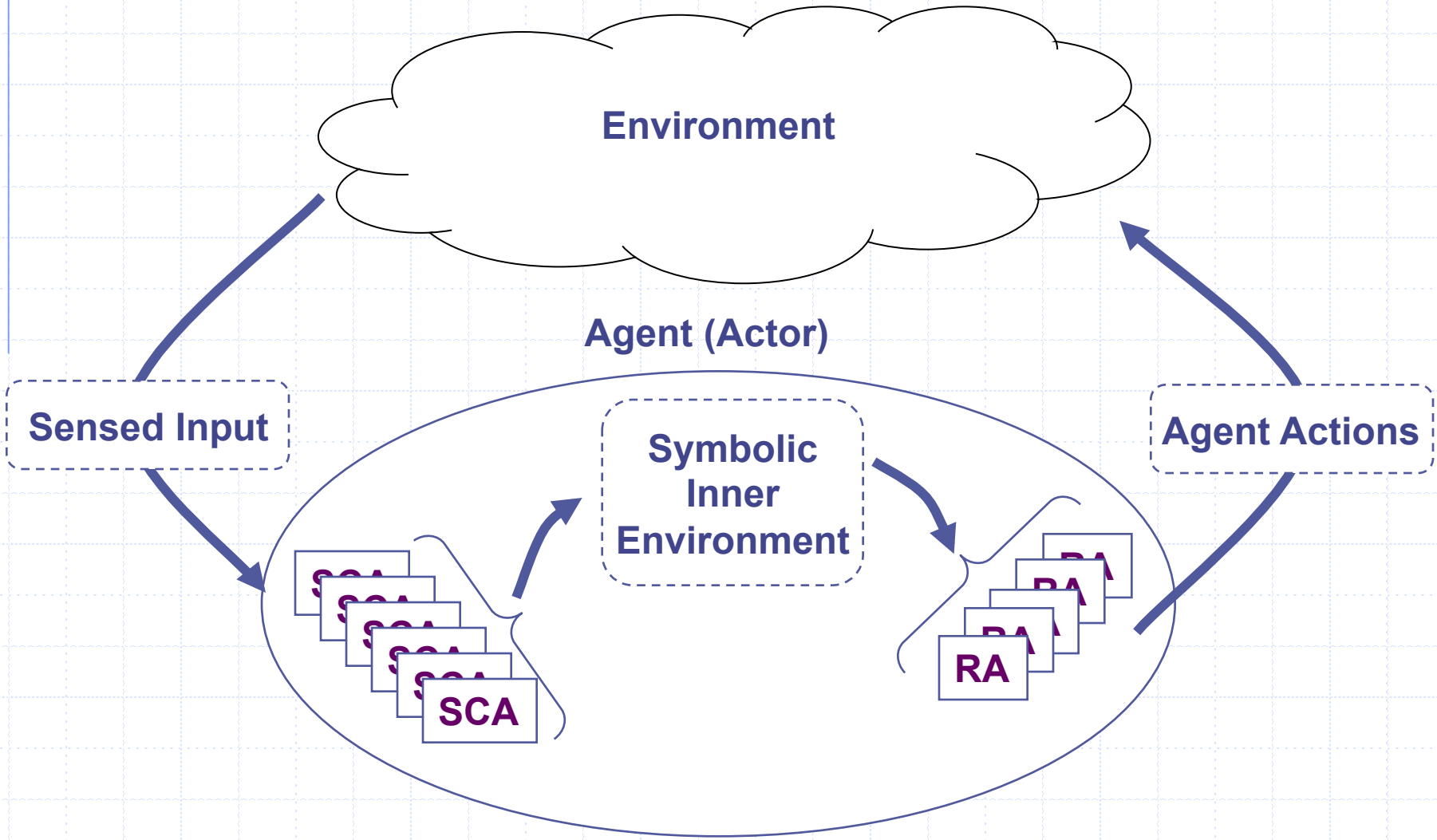
Interactive Story

- Believable Autonomous Characters
- Dramatic Presentation (Narrative Structure)
- Dynamic storyline that adapts to the user's interaction

Believable Characters



Composite Agent



Tickets

Constrain agent behavior when appropriate and provide a means for controlling events to promote the story.

nonsequential

sequential

sequential non-interruptible

sequential non-interruptible

Narrative Structure

Allows the story to progress from it's beginning, through the body of the story and finally to a climactic ending.

Aristotle's Poetics [Aristotle, ≈ 350 BC]

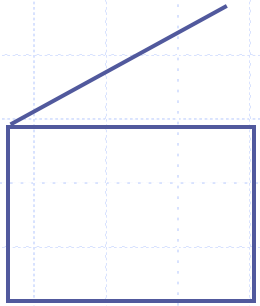
Storytelling in the New Hollywood [Thompson, 1999]

The Anatomy of a Screenplay [Siegel, 2001]

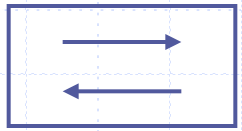
Myth and the Movies [Voytilla, 1999]

Dynamic Storyline

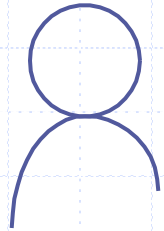
- Storyline that adapts to the participant's interaction and the state of the participant's character
- Bottom up approach
- Story elements combined at runtime to generate the story



Scenes



Interactions



Characters

Scene: Smoking

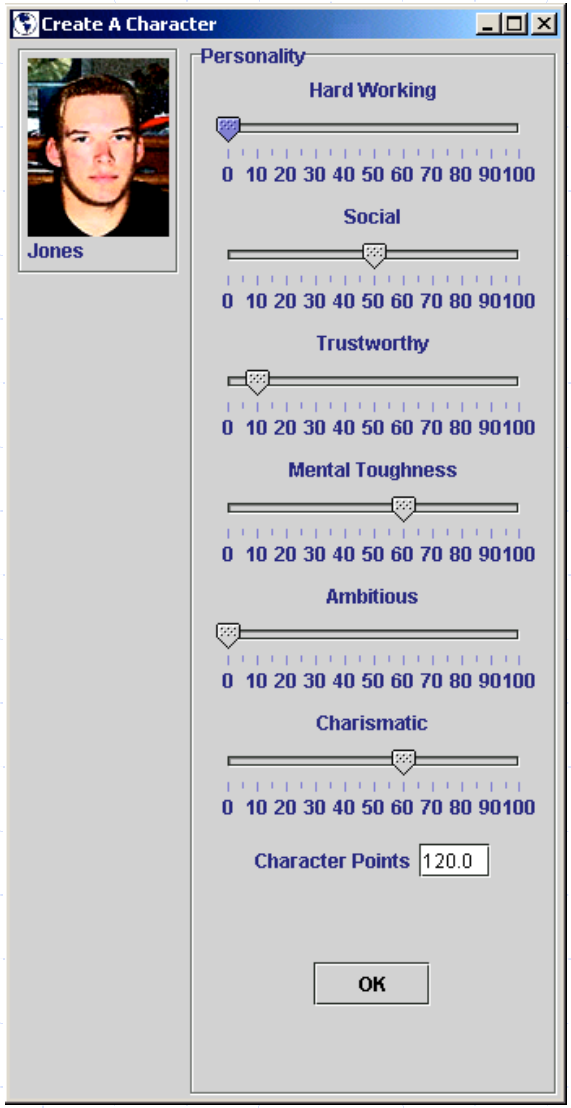
Main character is asked by a friend to sneak out of school for a cigarette.

Characters: Jones (Main Character), buddy (student), Teacher, Principal

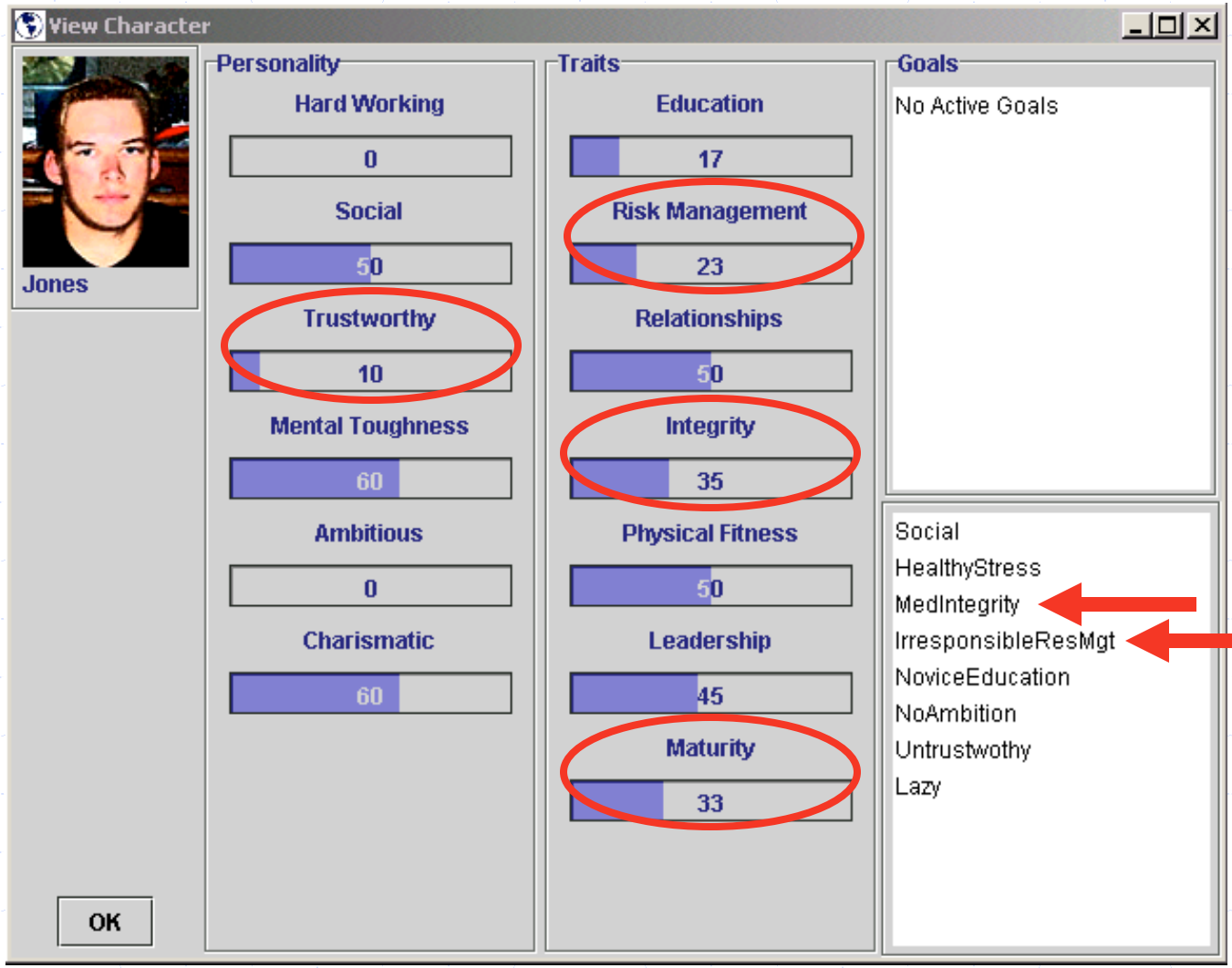
Character traits of interest:

- Integrity
- Maturity
- Trustworthy
- Risk Management

Create a Character



View Characteristics



Scene: Smoking (Run Away)

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** Setting ** <School hallway>

Buddy: Hey look, I've got some cigarettes.
Let's sneak around behind the gym and smoke 'em.

Jones: Oooohhh. I would kill for a cigarette. Let's go!

** Setting ** <Outdoors behind building>

Teacher: What are you two doing out here??!!

Jones: It's Mr. Smith! Run!!!

** Setting ** <Inside school's front office>

Teacher: Principal Myers you may want to be on the watch for Jones
and his sidekick. I caught them out back smoking, when they saw me,
they ran. They should be trying to get back in the building pretty soon.
If I catch them first I'll send them to you!

Post-Scene Characteristics

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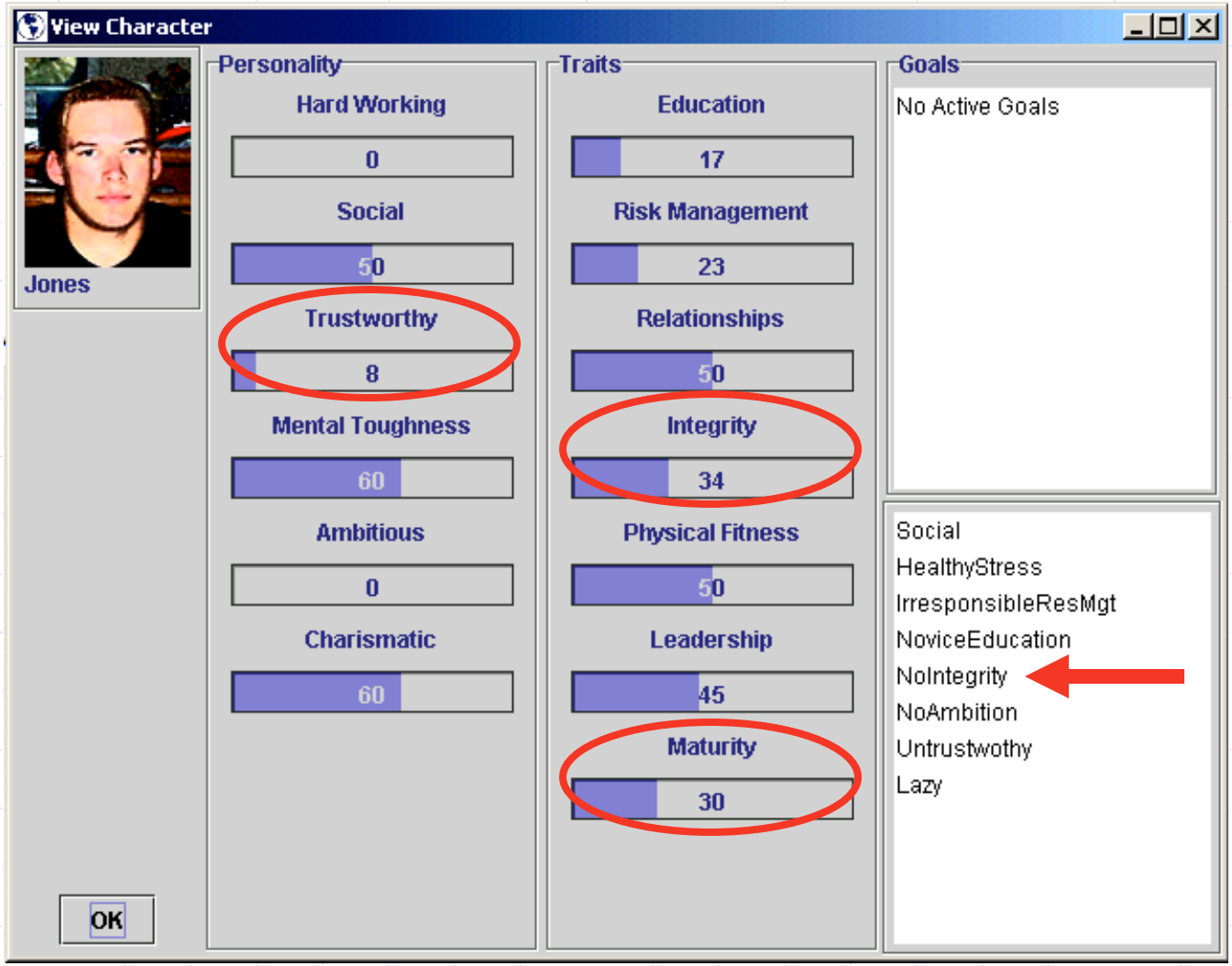

So what's the point?

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- Create realistic, believable stories and scenarios from a knowledge base of story elements relevant to a given problem domain
- Capture tacit knowledge and project through meaningful training scenarios and stories
- An advanced technique coupling autonomous believable behavior with story-based control

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Human Performance Engineering

Human Performance Engineering

- Virtual Environment Spatial Knowledge Training & Acquisition
- Virtual Technologies & Environments - Navy & Marine Corp Expeditionary Warfare
- DARPA Augmented Cognition - The Context Machine: Determining Context from Symbolic Inputs

MOVES Institute Human Performance Engineering Directions

Rudy Darken, Technical Director
Human Performance Engineering and Technologies for Immersion
darken@nps.navy.mil

VIRTE

OPERATIONAL MANEUVER FROM THE SEA

DEMONSTRATION I

LPD-17 San Antonio Class
Amphibious Warfare Ship

"Address the shortfall in the training cycle in between shore-based readiness training and arrival in theater. Maintain trained personnel."

EXPEDITIONARY FORCE TRIAD

AAAV
Advanced Amphibious Assault Vehicle

LCAC
Amphibian Hovercraft Landing Craft Air Cushion

MV-22 Osprey
Tiltrotor

VIRTUAL ENVIRONMENT TRAINING SYSTEMS

- **Deployable:** For use on-ship, very small footprint
- **Accessible:** Affordable, allowing easy-access as needed
- **Reconfigurable:** Multiple configurations and uses
- **Interoperable:** Multi-platform operations for team coordination
- **Team training:** Both within and between platforms
- **Novel operations:** Capable of simulating highly variable scenarios

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MV-22/Helicopter Training

VIRTE

Training Requirements

- Navigation
  - *Cultural feature and terrain recognition*
  - *Cockpit aids (TACNAV, GPS, INS, etc.)*
- Weapons employment procedures
  - *Sensor employment*
  - *Coordinating procedures*
  - *Target/threat recognition*
- Communications
  - *Crew/Flight/Mission*
- Aircraft Survivability Equipment (ASE)
  - *Programming/Recognition/Reaction*
- Procedural elements of basic flight maneuvers
  - *Advanced Inter-Deployment Training Cycle (IDTC) events*
    - *Starlight formation flight , LZ tactics and procedures*
    - *Fastrope, SPIE, duck operations, etc.*
  - *Emergency procedures*

Approach

Multiple configurations easily tailored based on:

- *What part of task is being trained?*
- *Who am I training with (individual/crew/mission)?*
- *What level of instruction/evaluation is required?*

Individual through CVW/MEU level coordination

Example configurations

- *AGM-114(K) remote designation procedures tutorial*
- *Reactionary CSAR training mission*
- *Emergent mission area communications plan verification*

Basic Principles

1. Retrofitted fixed wing trainers and mission rehearsal systems don't work for helicopter pilots. Mission profiles are way too different, thus the fidelity and interface requirements are completely different.
2. If a pilot doesn't have access to these trainers regularly, they won't be used at all. It needs to be a squadron level asset, thus it must be *inexpensive* and have a *small footprint*.
3. Part-task trainers work in many cases, so they need to be integrated with full task trainers whenever possible.

Implementation

PC-based to ensure both deployable and highly accessible

Integrated with existing planning tools (Plan a mission on PFPS, train that mission on VE-HELO)

Communicate via HLA and MAGTF/FOM, JSAF

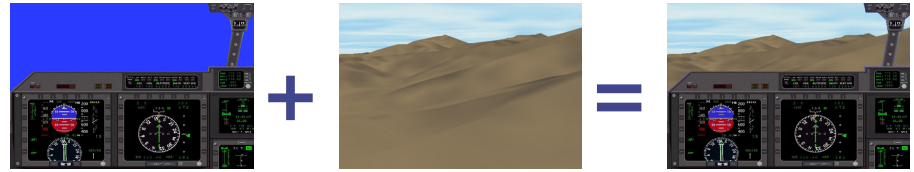
Tailored to rotary wing platforms

- *High fidelity terrain and urban models, but matched to the characteristics of low level, low airspeed flight*
- *Wide field of view display*

Computer Generated Forces, Agent models (hostile & friendly)

Instructional agent system for immediate performance monitoring and feedback

Scripted scenarios that can be modified



Chromakey™ "Bluescreen" approach to embedded training

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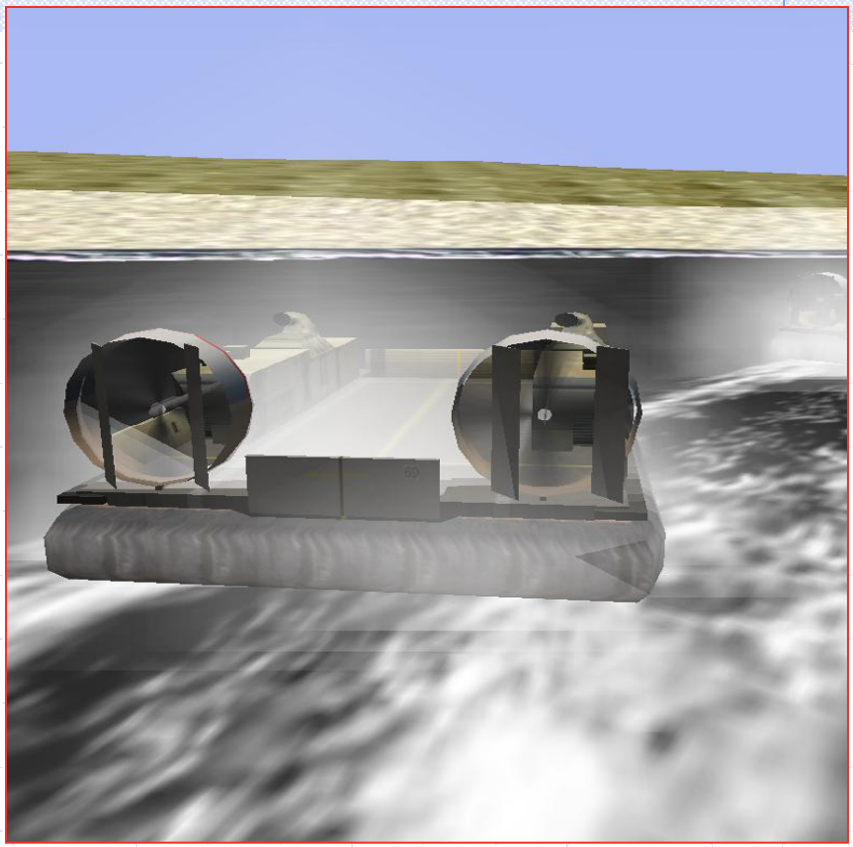
VE:LCAC PC



- Dynamic Sea
- Stern Wake
- Rear Fan Spray (color-based on terrain)
- Hover-Spray (color-based on terrain, with wind dynamics)
- Rotating Rear Fans (speed based on Prop Pitch)
- Semi-functional Autopilot-LCAC

In cooperation with NAWC-TSD

VIRTE

CLOSE QUARTERS COMBAT

DEMONSTRATION II

Building clearing

Team coordination

Initiative based tactics

"Focus on team building, cooperation, and communication between team members … the cognitive elements of CQC"

- *Cover immediate danger areas*
- *Shoot threat targets*
- *Protect each other*

VIRTUAL ENVIRONMENT TRAINING SYSTEMS

- **Cognitive Task Analysis:** Document elements of the task
- **Deployable:** Very small footprint, man portable
- **Networked:** Support large teams
- **Autonomous agents:** High fidelity, robust human behavior
- **Contingency preparation:** Experience high variability in uncontrollable events
- **Usability engineering:** Easy for anyone to use
- **Training effectiveness studies:** Ensure that CQC skills are being trained

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*Images taken from Rogue Spear from Red Storm, Inc.

VIRTE

FULL SPECTRUM COMBAT

DEMONSTRATION III

Air Combat Element

Amphibious Assault

Ground Combat Element
MOUT Operations

Forward Observers

Air Transport

CSAR/TRAP Operations

Naval Surface Fire Support

Call for Fire

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Tutoring Interactions

Pedagogical interfaces to virtual environments

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Objectives

- Describe how tutors provide information and feedback
  - pedagogical context of usage
  - content of information and feedback
- Demonstrate how this description can improve student learning from virtual tutor sessions

Technical Approach

- Describe a General Model of Tutoring Interactions
- Validate the General Model by Studying Real Tutors interacting...
  - ...face-to-face
  - ...over a computer network
- Determine Which Tutoring Interactions A Computer-Mediated Tutor can Achieve

Payoffs

- Improved understanding of:
  - the Structure of Context
  - our Sensing of Context
- AugCog Systems Able to Process Contextual Information
- AugCog Systems Display Feedback and Information that is more timely and valuable through context-sensitivity

Collaboration Research

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Explore VE interface effects on group collaboration

- Asses leadership personality traits (NEO-FFI)
- Developed Distributed Collaborative VE
- Users collaborate on dismounted land-nav task
  - Interact through avatar (DI-Guy) & Voice-over-IP
- Participants evaluated on leadership qualities
- Data collection & analysis on-going
  - Personality traits can overcome interface deficiencies

Maneuvering in VEs

- **Investigation of the effect of natural locomotion on maneuvering tasks in Virtual and Real Worlds**
  - The maneuvering behaviors of participants were observed in three different environments:
  - **VE Only (HMD, actual walking, no real objects inside the environment)**
  - **VE+Real (HMD, actual walking, real objects were placed at their exact locations)**
  - **Real Only (No interface or display mechanism)**
  - Participants actually walked in all three conditions
  - The performance levels in virtual conditions were not as good as in the real world condition.

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Perry McDowell
McDowell@acm.org

NPS Context Machine

Overview of AugCog

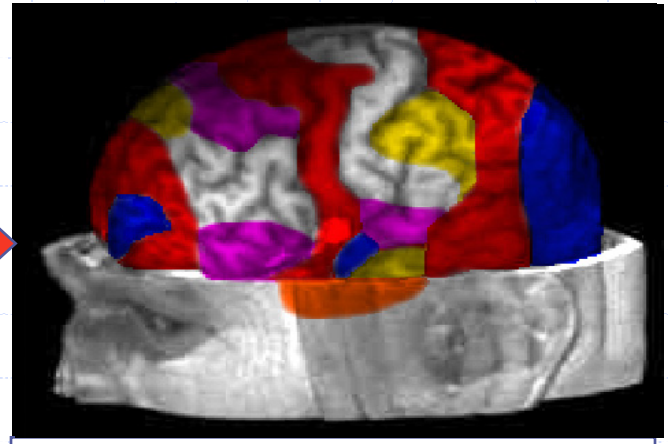
"AugCog is a DARPA project to extend the extend, by an order of magnitude or more, the information management capacity of the human-computer warfighting integral by developing and demonstrating quantifiable enhancements to human cognitive ability in diverse, stressful, operational environments."

-LCDR Dylan Schmorrow, PhD
AugCog Program Manager

AugCog Specifics

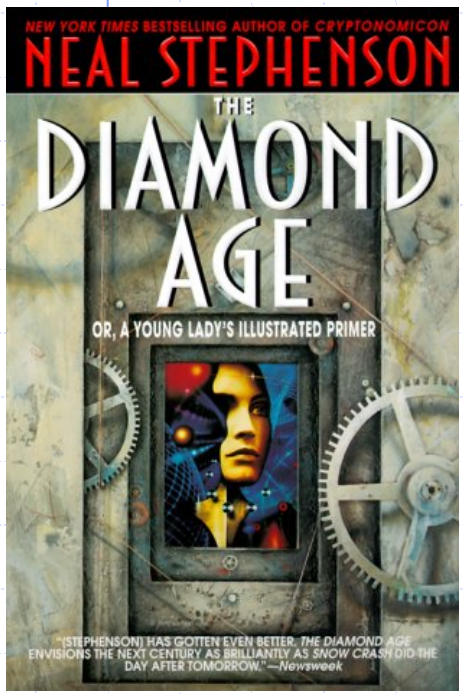
AugCog is designed to bring together researchers in a wide variety of disciplines

Goal is to bring more of the brain to the task



A Brain on Augmented Cognition

Literary Inspirations

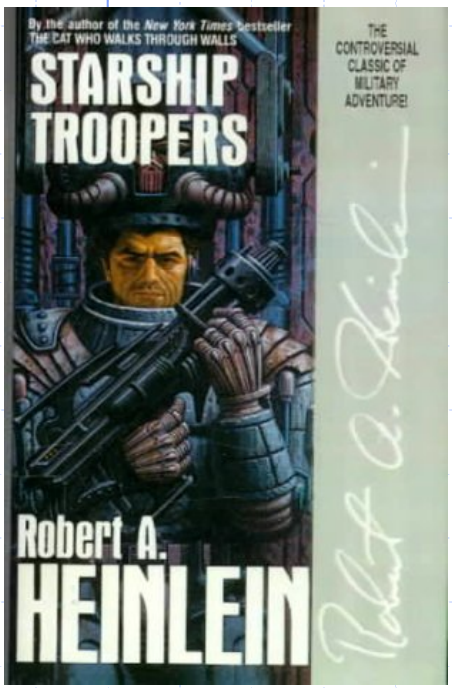


Diamond Age, Neal Stephenson

Futuristic novel of a young girl who discovers an interactive book which plays scenes demonstrating proper behavior of a young lady

She is able to drastically change her life by adhering to lessons learned in the book

Literary Inspirations



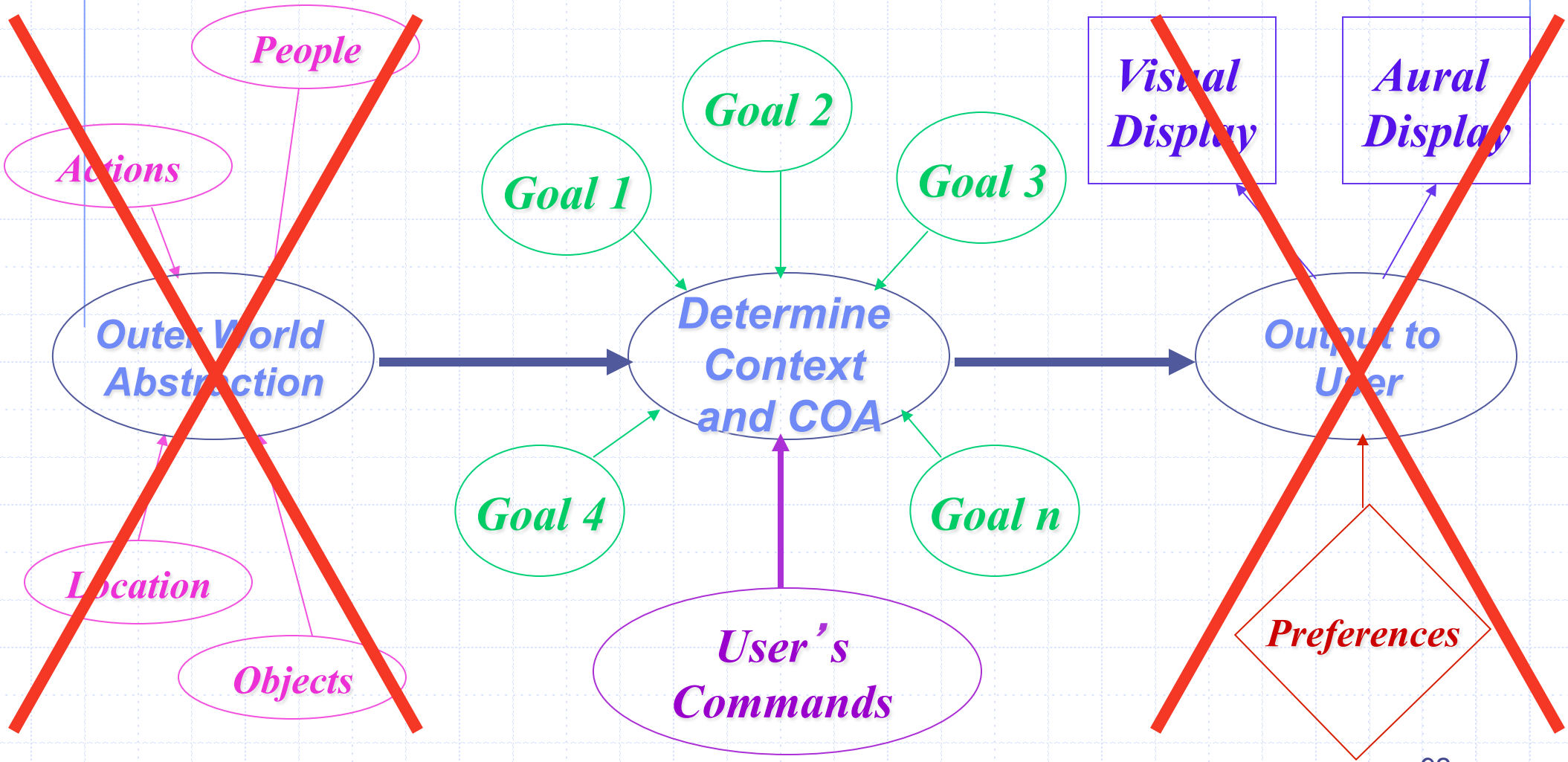
Starship Troopers, Robert A. Heinlein

Futuristic novel of a young man who joins the Mobile Infantry and fights in a intergalatic war

The soldiers wear an automated suit which greatly enhances their lethality and survivability

Give the same improvement mentally that the suits gave physically

Where Does the Context Machine Fit in AugCog?



Goals and Objectives of the Context Machine

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- Develop a robust, dynamic representation of knowledge which is sufficient to denote context
- Create a method to accurately transform symbolic sensory data from the environment into a data structure which can be used to determine context
- From the current context, determine a course of action that best meets the user's goals
- Accommodate shifting and divergent goals

Technical Approach

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- Begin by creating a context machine which works in a significantly reduced domain
- Agent-based machine learning approach:
  - Will use genetic algorithms
- Currently anticipate building two different types of agents
  - Symbolic constructor agents (SCA) are used to build a "topography" in an inner world which represents the outer world
  - Symbolic reactive agents (SRA) explore this inner world to search the topography and make judgments, inferences and recommendations

Graphical Representation of Technical Approach

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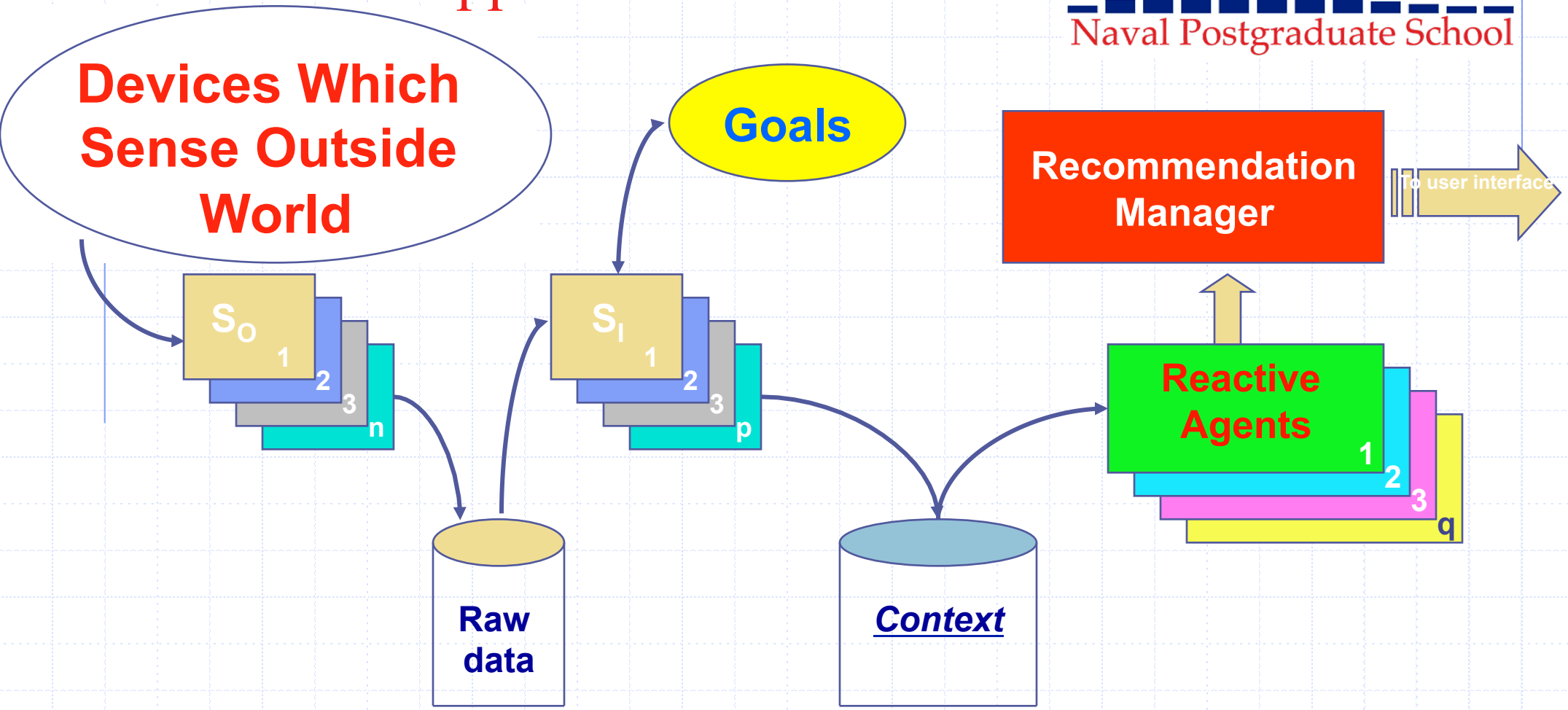

Based upon research of John Hiles, Brian Osborne and Mike van Putte

Short Term Implementation

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- Intend to demonstrate rudimentary context sensing capability
- Creating an application which can determine the context of a situation and react appropriately
- Chosen Environment:
  - Military unit on patrol

Payoff/Impact

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- A mechanism for accepting symbolic information from a sensory stream and inserting it into a robust dynamic architecture for representing context
- Capable of learning new and novel situations while in use
- Monitors user's goals and assists where appropriate
- Adaptable to wide variety of users

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Technologies for Immersion

Technologies for Immersion

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- CDTEMs - A VR CAVE for the MOVES Institute
- Hybrid Inertial Motion Tracking for Inserting Humans into Networked Synthetic Environments

An Improved Quaternion-Based Filtering Algorithm for Real-Time Tracking of Human Limb Segment Motions using Sourceless Sensors

Eric Bachmann, Xiaoping Yun, Robert McGhee, & Michael Zyda
bachmann@cs.nps.navy.mil

Inertial / Magnetic Body Tracking

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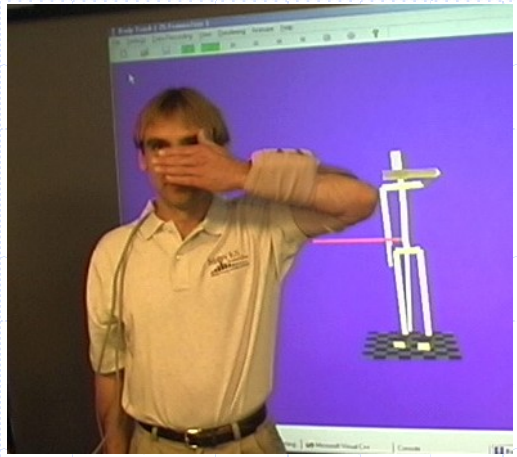
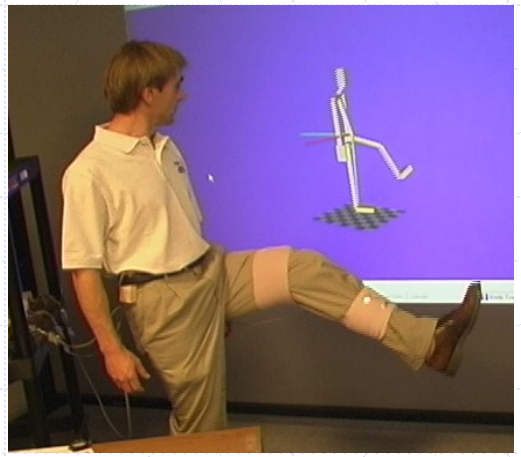
Body posture can be ascertained by attaching inertial / magnetic sensors to human limbs

Based on the passive measurement of physical quantities directly related to motion and attitude. ("Sourceless")

- Each segment is oriented independently
- Segments are positioned relative to each other by adding rotated limb-translation vectors

Position data for a single reference point is needed to place the avatar within a virtual environment.

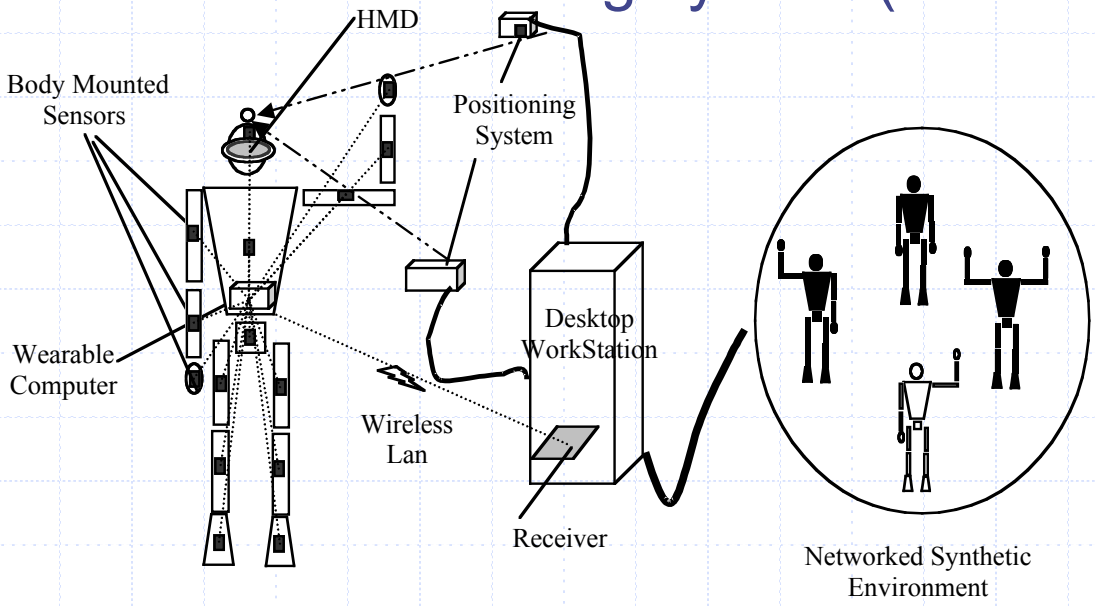




Goal

Wireless full body tracking system based on inertial/ magnetic orientation sensing

- MARG sensors are used to determine posture
- Position of one point on the body tracked using a simple optical or ultrasonic tracking system (DGPS outdoors)



Magnetic Angular Rate Gravity (MARG) Sensors

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3-DOF MARG sensors have nine-axes

- Three-axis rate sensor
- Three-axis accelerometer
- Three-axis magnetometer

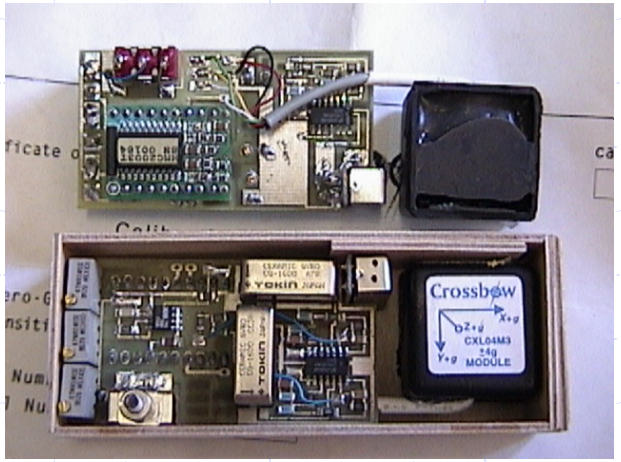
Three-axis accelerometer senses the three components of the gravity vector in body coordinates

- Sensed accelerations must be averaged over time

Three-axis magnetometer senses three components of the magnetic field vector in body coordinates

Rate sensor data gives velocity of rotation

- Quickens response by providing short-term orientation estimates



A Complementary Quaternion Attitude Filter - Block Diagram

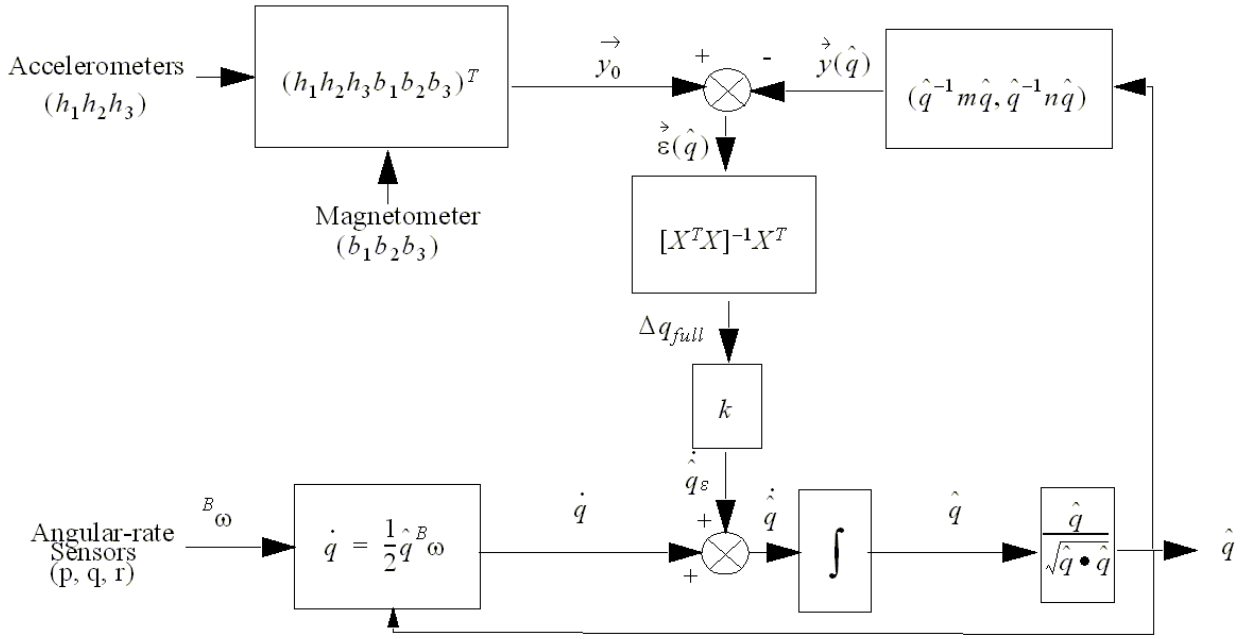
The quaternion-based complementary estimation filter estimates attitude

Combining of filter inputs is treated as a parameter optimization problem

Error minimization is accomplished by adjusting the derivative of the estimated orientation quaternion, *"q-hat"*

Tracks through all orientations without singularities

Continuously corrects for drift



MARG Sensor Improvements

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MARG-0-1

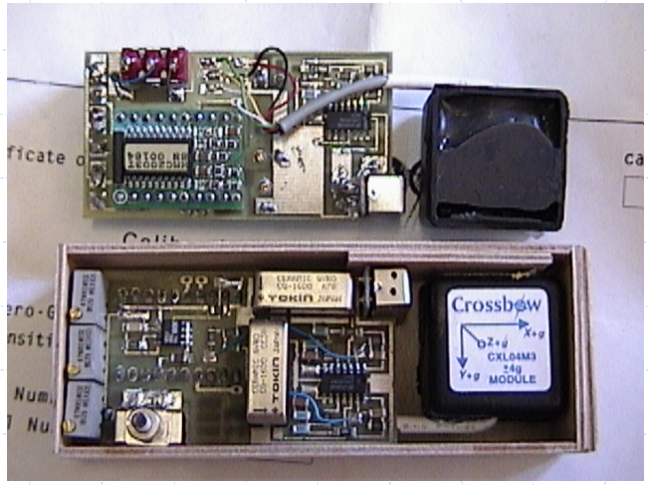
Rate and Magnetometer drift issues became evident, requiring repeated calibrations.

- Drift due to temperature affects from power supply regulator
- Magnetometer was influenced by any magnetic or ferrous metals

MARG-0-2

Drift problems were reduced by:

- Moving power regulator off main board
- Improved rate sensor electronics
- Manual magnetometer calibrator
- Adjustable magnetometer offsets



Periodic calibrations still required

Second Generation MARG Sensor Units

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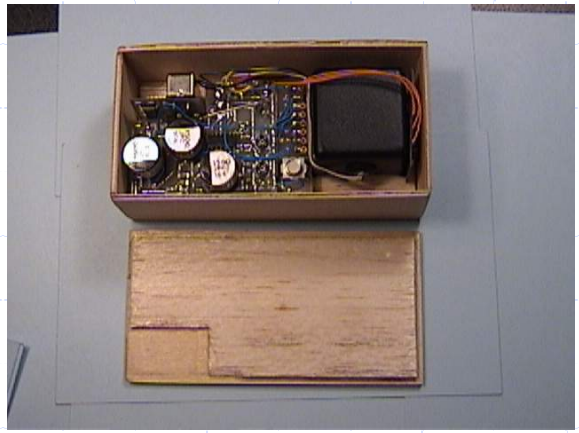
MARG-1-0 R & D

Second generation sensors have been delivered.

- Reduced form factor
- Capacitive coupling
  - Superior drift characteristics
  - Accurate tracking with reduced gain values
- Buffer stage reduces noise feedback and provides low impedance signal to analog to digital converter
- Getting closer to removing calibration limitations to system design.



Third Generation MARG Sensor Units

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MARG-2-0 R&D

Third generation sensor design stage nearing completion

- Miniaturized components – flat form factor
- Onboard microprocessor and A to D converter
  - digital output
- Continuous digital set/reset of magnetometers
  - Automatic temperature compensation
  - Eliminate need for repeated calibrations
- Incorporation of onboard microprocessor will make possible filter implementation on the sensor itself
- Tether cable will have 5 wires instead of 14 wires

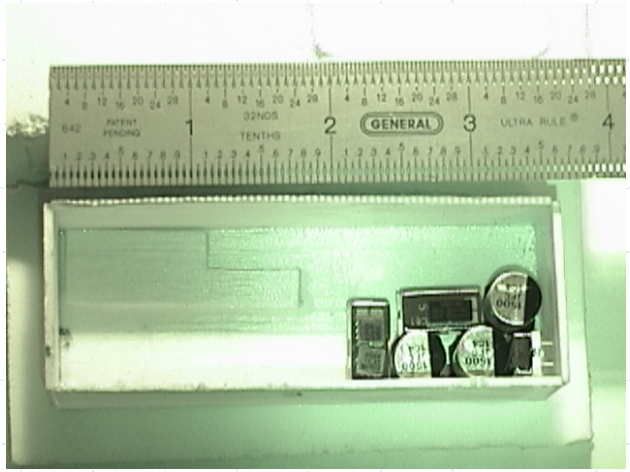

Illustration shows MARG2-0 major components in the MARG-0-0/1/2 enclosure box

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Modeling & Simulation

Modeling & Simulation

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- Modeling Tactical Level Combat Using A Multi-Agent System Design Paradigm (GI-AGENT)
- Modeling Conventional Land Combat Using Generalization of the Different Combat Entities and Combat Operations in a Multi-Agent System
- Scenario Authoring and Visualization for Advanced Graphical Environments (SAVAGE): Amphibious Raid at Red Beach, Camp Pendleton California
- Modeling and Simulation of the Ocean Environment

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Evolving Operational Modeling

Evolving Operational Modeling

- Evolving Operational Modeling - Navy Concepts, Research, & Analysis Network (NCRAN)
- Course Development
  - Hands-on Operational Modeling
  - Current Programs in Operational Modeling

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Defense & Entertainment Collaboration

Defense & Entertainment Collaboration

- Audio Engineering and Sound Design Issues in VE: Lessons Learned from the Entertainment Industry
- The MOVES Institute War Game Laboratory - A Videogame Research & Production Facility
  - SimSecurity - A Distance Learning and Virtual Laboratory for Information Assurance
  - Army Game Project

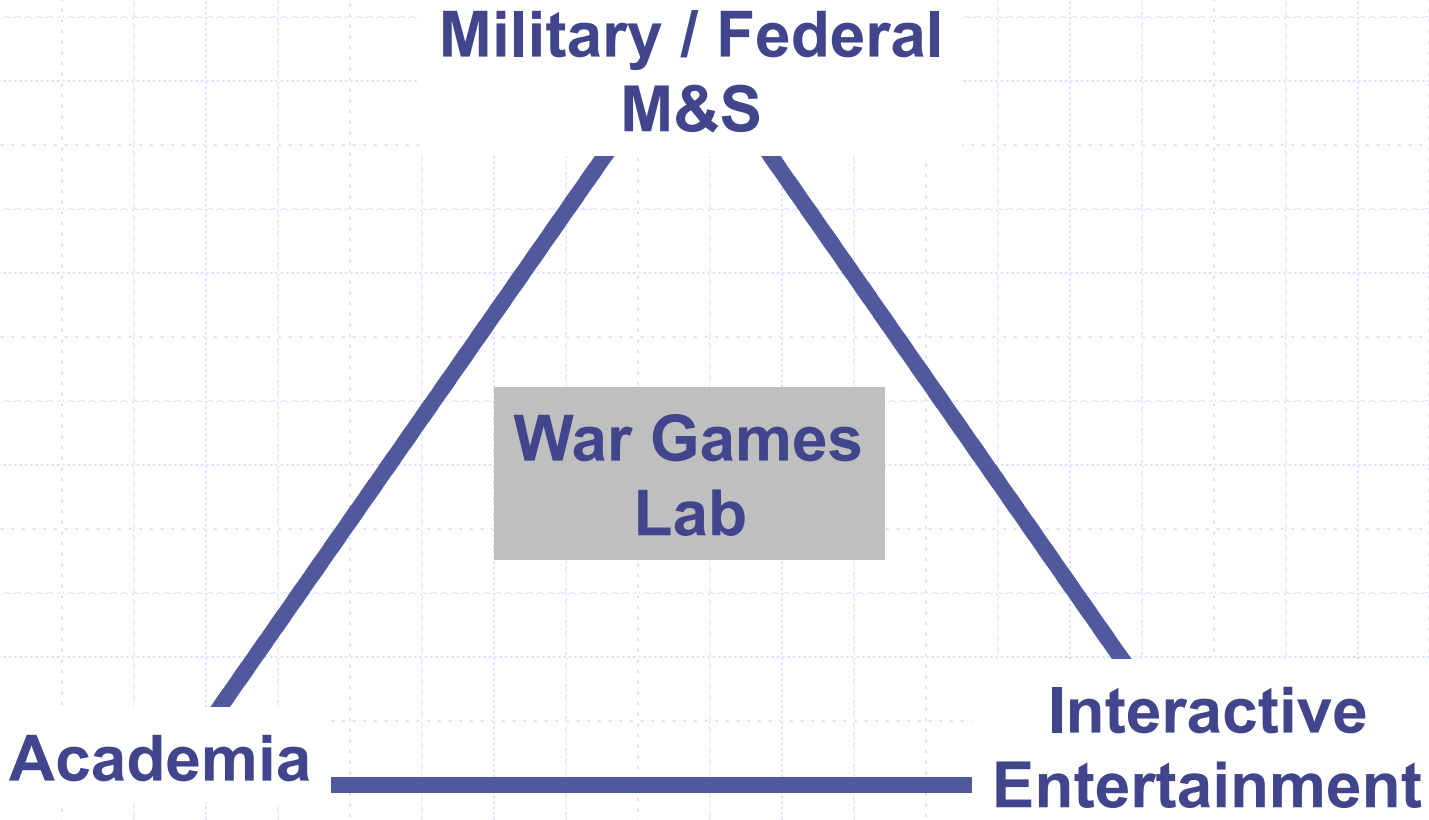
The War Games Lab - A Videogame Research & Development Facility

Dr. Michael Capps
Naval Postgraduate School
Technical Director
Defense-Entertainment Collaboration

Mission

- Support collaboration between entertainment and defense industries
- Leverage entertainment software for military simulation, training, and operations
- Leverage entertainment software for academic research

Small Aspirations



How?

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We combine expertise in each of those three areas:

- We are an academic institution
- with entertainment partners
- and military/federal partners and sponsors

We have research faculty, game development staff, and graduate students

Research Facility

The MOVES Institute
Naval Postgraduate School

we have multiple projects supported by federal and military agencies

also have research projects sponsored by entertainment companies

- 7 fully-engaged MOVES faculty
- 10+ graduate students

Production Facility

- world-class production team
- game company hidden inside the Naval Postgraduate School
- talent from top entertainment companies

Production Facility

The MOVES Institute
Naval Postgraduate School

production staff

- five programmers
- five artists
- six world designers
- multiple graduate student programmers
- and military Subject Matter Experts

Production Facility

The MOVES Institute
Naval Postgraduate School

- numerous ongoing projects using commercial game engines
  - training, modeling, and simulation
- We are growing rapidly and wish to continue doing so!

Model Building: the UH-60

Model Building: the UH-60

Model Building: the UH-60

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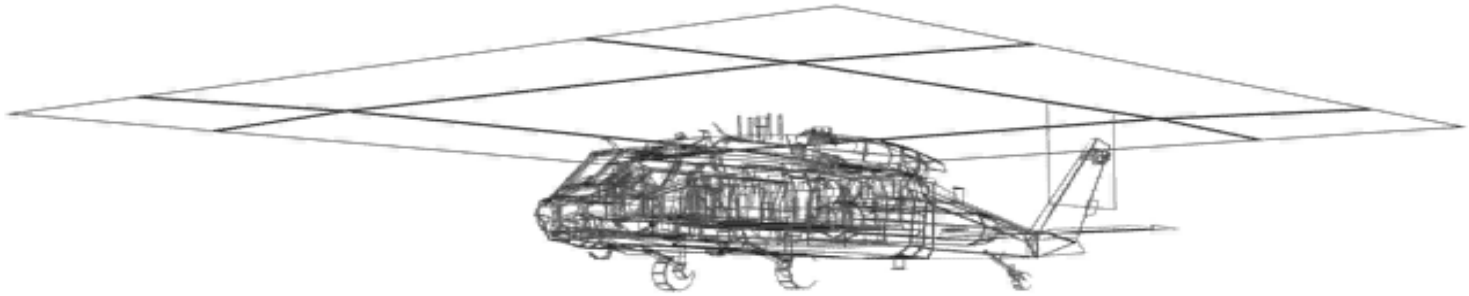



Ver 739.3.5
Model Building: the UH-60


Ver 739.3.5
Model Building: the UH-60

Air Assault School

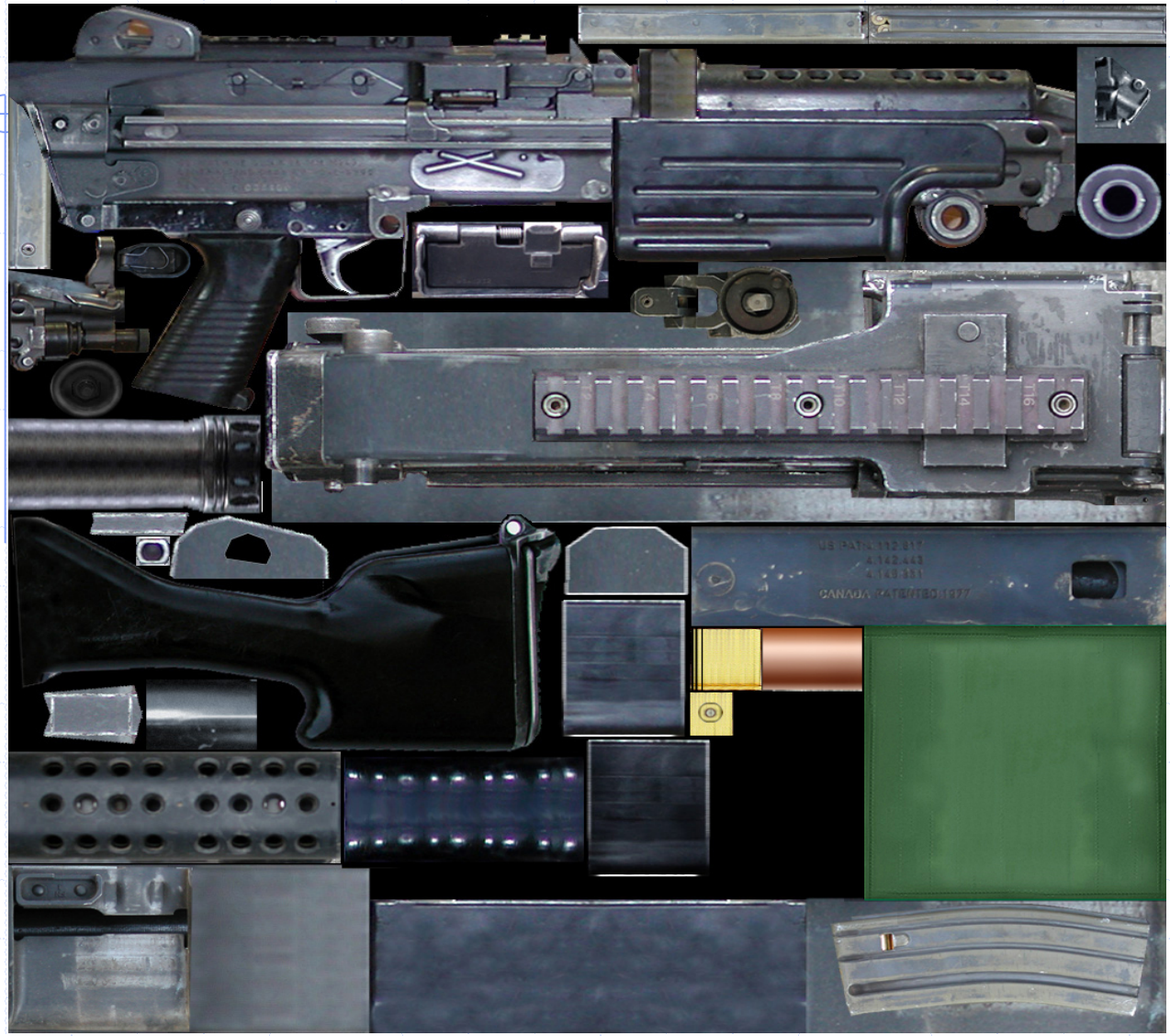

Ver 739.4.3
THE AIR ASSAULT
SCHOOL
Air Assault School


Ver 739.4.3
AIRBORNE
The Sabalauski
Air Assault School
Obstacle Course
By order of the Commanding General
AIRBORNE
THE AI SSAULT
SC OL
Air Assault School


Ver 739.4.3
NE
THE AIR ASSAULT
SCHOOL
Air Assault School

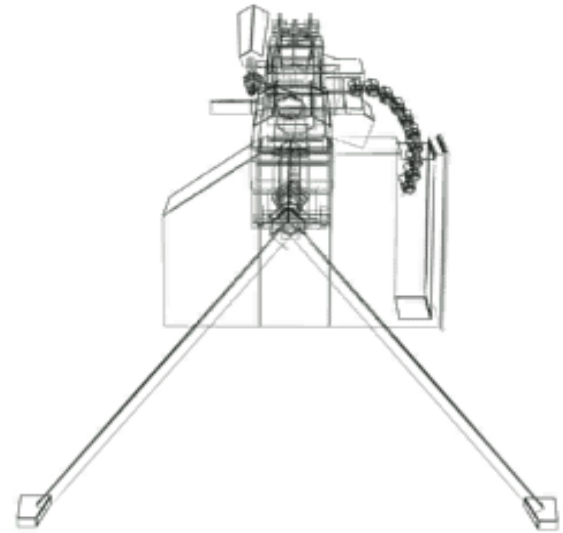
Weapon Modeling:
M-249 SAW

Weapon Modeling:
M-249 SAW



Texture map for M249

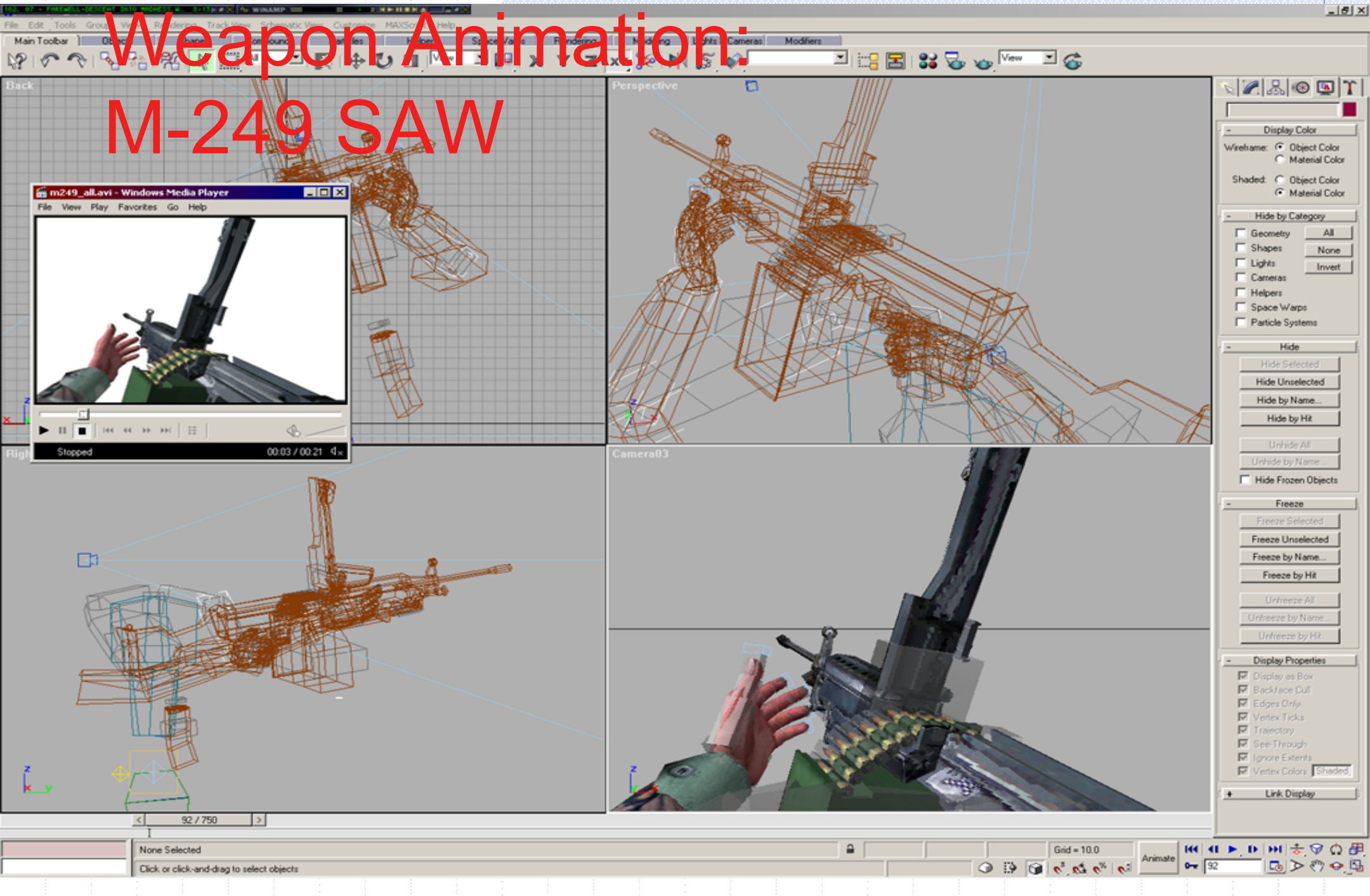
Weapon Modeling: M-249 SAW




Weapon Animation:
M-249 SAW

Weapon Animation:
M-249 SAW

Weapon Animation:
M-249 SAW



Weapon Animation:
M-249 SAW

Click here for movie: 5.5MB AVI

Conclusion

The MOVES Institute
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- We've got research & development capability
- We'd like to know about your game-repurposing M&S projects
- We're looking for partners of all kinds

In closing

http://movesinstitute.org